



Volume 1 of 3



**MIDWESTERN STATE UNIVERSITY
HEALTH SCIENCE & HUMAN SERVICES CENTER
WICHITA FALLS, TEXAS**

RSA Project #1612.00

100% CONSTRUCTION DOCUMENTS

September 1, 2017

SECTION 000107

SEALS PAGE

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102233	Horizontal Sliding Accordion-Type Fire Door	Sept. 1, 2017	
102613	Wall and Corner Guards	Sept. 1, 2017	
102813	Toilet Accessories	Sept. 1, 2017	
104400	Fire Protection Specialties	Sept. 1, 2017	
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220700	Plumbing Insulation	Sept. 1, 2017	
221116	Domestic Water Piping	Sept. 1, 2017	
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221123	Domestic Water Pumps	Sept. 1, 2017	
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221316	SANITARY WASTE AND VENT PIPING	Sept. 21, 2017	Feb. 28, 2018
221319	SANITARY WASTE PIPING SPECIALTIES	Sept. 21, 2017	
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221413	Facility Storm Drainage Piping	Sept. 1, 2017	Feb. 28, 2018
221415	Facility Subsoil Drainage Piping	Sept. 1, 2017	
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223100	Domestic Water Softeners	Sept. 1, 2017	
223300	Electric Domestic Water Heaters	Sept. 1, 2017	
223500	Domestic Water Heat Exchangers	Sept. 1, 2017	
224000	Plumbing Fixtures	Sept. 1, 2017	
224500	Emergency Plumbing Fixtures	Sept. 1, 2017	
224700	Drinking Fountains and Water Coolers	Sept. 1, 2017	
226113	Medical Compressed Air Piping for Healthcare Facilities	Sept. 1, 2017	
226119	Compressed Air Equipment for Healthcare Facilities	Sept. 1, 2017	Feb. 28, 2018
226213	Vacuum Piping for Healthcare Facilities	Sept. 1, 2017	
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226313	Gas Piping for Healthcare Facilities	Sept. 1, 2017	

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230513	Common Motor Requirements for HVAC Equipment	Sept. 1, 2017	
230516	Expansion Fittings and Loops for HVAC Equipment	Sept. 1, 2017	
230519	Meters and Gages for HVAC Piping	Sept. 1, 2017	
230523	General Duty Valves for HVAC Piping	Sept. 1, 2017	
230529	Hangers and Supports for HVAC Piping and Equipment	Sept. 1, 2017	
230548	Vibration and Seismic Controls for HVAC Piping and Equipment	Sept. 1, 2017	
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231123	Facility Natural Gas Piping	Sept. 1, 2017	
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233300	Air Duct Accessories	Sept. 1, 2017	Sept. 21, 2017
233400	HVAC Fans	Sept. 1, 2017	
233600	Air Terminal Units	Sept. 1, 2017	
233713	Diffusers, Registers, and Grilles	Sept. 1, 2017	
234000	HVAC Air Cleaning Devices	Sept. 1, 2017	
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237313	Modular Indoor Central Stations Air Handling Units	Sept. 1, 2017	Sept. 21, 2017
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262816	Enclosed Switches and Circuit Breakers	Sept. 1, 2017
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262913	Variable-Frequency Motor Controllers	Sept. 1, 2017
263213	Engine Generators	Sept. 1, 2017
263353	Static Uninterruptible Power Supply	Sept. 1, 2017
263600	Transfer Switches	Sept. 1, 2017
264113	Lightning Protection for Structures	Sept. 1, 2017
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271100	Communications Room Fittings	Sept. 1, 2017
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274113	Architecturally Integrated Audio Visual Infrastructure	Sept. 1, 2017
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282600	Emergency Intercom and Duress	Sept. 1, 2017
283100	Fire Detection and Alarm	Sept. 1, 2017
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321314	Concrete Paving Architectural Finishes <i>(Deleted)</i>	Sept. 1, 2017	<i>Feb. 28, 2018</i>
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321600	Concrete Curbs and Gutters	Sept. 1, 2017	
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SECTION 007400

ARCHITECT'S SPECIAL CONDITIONS

1.1 SPECIAL CONDITIONS

- A. The following special conditions shall apply to this project.

ARTICLE 1 GENERAL PROVISIONS

1.1.9 MISCELLANEOUS DEFINITIONS

1.1.9.1 The term "Product" as used in these Contract Documents includes materials, systems, and equipment.

1.1.9.2 The term "provide" as used in this Project Manual means to furnish and install.

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

1.2.4 The inter-relation of the Project Manual, the Drawings and the schedules is as follows: The Project Manual determines the quality, nature and setting of the several materials; the Drawings establish the quantities, dimensions and details; and the schedules give the location. **The documents are to be considered as one and whatever is called for by any one shall be as binding as if called for by all.**

1.2.5 Should the drawings disagree in themselves, or with the Project Manual, or if proprietary information disagrees with performance requirements in either the Drawings or the Project Manual, the better quality or greater quantity of the Work or materials shall be estimated upon, and unless otherwise ordered by the Architect in writing, shall be performed or furnished. Should discrepancies or doubt occur, do not proceed with the Work without clarification from the Architect. Contractor shall request clarification in sufficient time to avoid delays and increases in the contract sum.

ARTICLE 3 CONTRACTOR

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

3.2.2.1 If a dimensional discrepancy exists, Contractor shall take field measurements required for proper fabrication and installation of work. Upon commencement of any item of work, Contractor shall be responsible for dimensions related to such item of Work and shall make any corrections necessary to make work properly fit at no additional cost to Owner.

3.2.2.2 Before ordering any material or doing any work, Contractor shall verify dimensions and check conditions in order to assure himself that they properly reflect those on the Drawings. Any inconsistency shall be brought to attention of the Architect. In the event that discrepancies occur between ordered material and actual conditions, of which Architect was not notified beforehand, costs to correct such discrepancies shall be borne by Contractor.

3.4 LABOR AND MATERIALS

3.4.4 After the Contractor's Contract and a Notice to Proceed have been executed, the Owner and the Architect will consider a formal request for the substitution of products in place of those specified only in the event that the originally specified product becomes unavailable from the manufacturer due to unforeseen hardship (verification of which shall be determined by the Architect) or acts of God. Note: Contractor not ordering long lead items in time for properly sequenced installation per the schedule is not an acceptable reason for requesting a substitution

and will be denied in such situations. Contractor shall order the originally specified product, paying required expediting fees, and cover all costs required for a recovery schedule. Refer to Section 016000, Product Requirements for supplemental information.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

6.1.5 Coordinated construction work under this Contract includes, but is not to be limited to, providing concealed blocking as noted for attachment of separate contract items in locations necessary for the actual items to be installed. Providing proper dimensional coordination of separate contract supplied items for general construction work and trim that is to meet and/or adjoin Furniture, Fixtures, Equipment and Accessories.

6.1.6 It is a requirement of the Contractor's work schedule to provide the cooperation, coordination and exchange of information necessary for a timely execution of separate contract work.

ARTICLE 7 CHANGES IN THE WORK

7.1 GENERAL

7.1.4 Except as provided in this article, no oral statement, or direction of Architect shall be treated as a Change Order or entitle Contractor to an adjustment to the Contract Sum or the Contract Time.

7.1.5 Unit prices shall be inclusive of all costs including mark-up for overhead and profit and shall be applied to units of measure as defined in the Contract Documents for each category of Work.

MOCK-UPS

1. Before installing portions of the Work requiring mock-ups, build mock-ups for each form of construction and finish required, using materials indicated for the completed Work.
2. Build mock-ups in location and of size indicated or, if not indicated, as directed by Architect. The mock-up may be work in place that is intended to remain, unless otherwise directed by the Owner.
3. Notify Architect and Owner five (5) working days in advance of dates and times when mock-ups will be constructed.
4. Demonstrate the proposed range of aesthetic effects and workmanship. Include anticipated repairs in mock-up, such as stone veneer.
5. Obtain Architect's and Owner's approval of mock-ups before starting work, fabrication, or construction.
6. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mock-ups when directed, unless otherwise indicated.
8. For any of the following work items included in the project, a mock-up shall be prepared whether required by the technical section or not:
 - a. Exterior Wall: 10 ft high by 8 ft wide to include: substructure, air barrier, flashing, weeps, ties, sheathing, masonry, cast stone, sealants, terra-cotta, plaster, soffits, edge trim, architectural concrete, metal coping, and a 2 ft square curtainwall window with the specified vision and fritted glass panels.
 - b. Roof:
 1. Clay roof tiles.
 2. Modified bitumen.
 - c. Interior wall finishes: 8 ft wide by 8 ft high.
 - d. Ceramic tile: 6 ft wide by 6 ft high.
 - e. Finished flooring: 8 ft square.

Weather Delays: Weather delays will only be granted for days that are more than the quantity for a given time period exceeding NOAA data for that given time period.

END OF SECTION

SECTION 008900

FINISH SELECTION SUMMARY

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The following list is a compilation of materials and products that are standards for this Project.
 - 1. It is intended to extend information in the technical specification sections by giving specific texture, finish, manufacturer, and model number of finish products, and to link the Specifications with the Drawings.
- B. Where other manufacturers are listed herein or in other sections of the Project Manual/Specifications as acceptable, products of these may be submitted **for evaluation by the Architect. However, determination by the Architect regarding equivalency will be made on a product-by-product basis and the listing of a manufacturer as acceptable may not necessarily imply that the particular product submitted will be accepted as an equivalent.** Refer to section 012500 Substitutions for additional information.

PART 2 - SUMMARY OF FINISHES

DIVISION 03 - CONCRETE

DIVISION 04 - MASONRY

2.1 04 20 00 Unit Masonry

- A. **Face Brick**
 - 1. **Description:** 8" modular face brick. Provide solid brick and special shapes as required to construct the project.
 - 2. **Acceptable Products:**
 - a. **BR-1 (Option 1):** Brick product by Cloud Ceramics.
 - 1) 40% Driftwood Grey
 - 2) 40% Terra Cotta
 - 3) 10% Cimarron
 - 4) 5% Old Rose
 - 5) 5% Cameo
 - b. **BR-2 (Option 2):** Brick product by Acme Brick, Ft. Worth, TX
 - 1) Brick product by Acme Brick, Ft. Worth, TX that matches the campus blend to be determined between the Architect, CMAR and Acme Brick Co.
 - 3. **Joint Type:** Concave, tooled.
 - 4. **Joint Size:** 3/8" maximum. No exceptions!
 - 5. **Bond:** Place units in running bond unless noted otherwise on the drawings.
 - a. Provide accents in soldier, rowlock and stretcher courses where indicated on drawings.
 - 6. Provide samples and mock-up
- B. **Mortar Color:** To be selected by Architect from any manufacturers' full and complete color lines. Provide four mortar colors on mock-up as directed by Architect for selection. Upon final selection, rake unapproved mortar colors from mock-up and replace with approved color for Architect's final approval. Generally, the intent is to match the campus standard mortar color.

2.2 04 72 00 Cast Stone Masonry

- A. **Cast Stone Plinths, Belt Courses, Banding, Sills, Headers, Coping and Miscellaneous Trim Pieces** as indicated on the drawings.
- B. **Color and Texture:** Custom color to match Architect's sample.
- C. **Samples and Mock-up:** Submit partial and/or full sized samples of each shape and size in the approved color for Architect's approval. Install approved color pieces on mock-up for Architect's approval prior to fabricating pieces to be installed on the project.
- D. **Mortar Color:** To be selected by Architect from any manufacturers' full and complete color lines. Provide four mortar colors on mock-up as directed by Architect for selection. Upon final selection, rake unapproved mortar colors from mock-up and replace with approved color for Architect's final approval. Generally, the intent is to match the campus standard mortar color.

DIVISION 05 – METALS

2.3 05 50 00 Metal Fabrications

- A. Refer to Sections 05 50 00, 09 91 00 and 09 97 13.
- B. **Finish:** Paint. Refer to individual spec sections, section 055000 schedule, finish plans and other drawings for type of painted finish.
- C. **Color:** to be selected by Architect.

2.4 05 51 00 Metal Stairs

- A. Refer to Sections 05 51 00 and 09 97 13.
- B. **Finish:** Epoxy paint, ref. 09 97 13
- C. **Color:** to be selected by Architect.
- D. **Offset:** Offset top riser one tread width to allow continuous curved handrail and guardrail at inside switchbacks.

2.5 05 51 33 Metal Ladders:

- A. Refer to Sections 05 51 33 and 09 97 13.
- B. **Finish:** Epoxy paint, ref. 09 97 13
- C. **Color:** to be selected by Architect.

2.6 05 52 13 Pipe and Tube Railings

- A. Refer to Sections 05 52 13 and 09 97 13.
- B. **Finish:** Epoxy paint, ref. 09 97 13
- C. **Colors:** to be selected by Architect. Note: all pipe and tube railings shall be two color paint combination. Confirm final colors and locations of each color with Architect.

2.7 05 73 00 Decorative Railings

- A. **Exterior Handrails and Guardrails at Entrance Steps and other locations as indicated on drawings:**
 - 1. **Design:** refer to drawings for type and locations.
 - a. **Handrails at Building Entrances:** Stainless steel 1 ½" diameter handrails meeting required codes at all entrances.
 - b. **Guardrails at Grade Changes or Entrances:** Stainless steel 1 ½" diameter guardrails and handrails with intermediate members as required to meet required codes and 4" sphere limitation. If intermediate members are not indicated on drawings, submit request to Architect for clarification.
 - 2. **Finish:** Brushed stainless steel, # 4 finish.
- B. **Interior Grand Stair & Elevated Balcony Railings:**
 - 1. **Basis of Design:** Viva Modular Railing Systems, 1454 Halsey Way, Carrollton, TX 75007, Ph. 972.353.8482. "Blade - Cable Rail" stainless steel combination Guardrail/Handrail System with 3/16" diameter stainless steel horizontal tension

cable infill at 3 1/4" on center. Substitutions will be considered by the Architect on a case by case basis.

- a. **Materials:** Type 304 or 316 (as recommended by manufacturer) 1-1/2-inch stainless steel guardrail and handrails.
- b. **Mounting at Base:**
 - 1) **First Floor Grand Stair and Second Floor Balcony Railing at East Atrium 100** - Install with four 1" diameter brushed stainless steel standoffs attached to side of stringer or concrete slab edge using 6"W x 8"H x 1/4" thick stainless steel plates welded to verticals.
 - 2) **All other locations U.N.O.** – *Employ railing manufacturer's standard fascia mount details for mounting vertical posts to concrete structure. Insure embed plates or mounting studs, cast into the concrete, do not interfere with the structural reinforcing in the concrete. (Addendum #10)*
- c. **Verticals:** Two 2" wide vertical stainless steel bars with cube cap top and side mount base as described in item b. at bottom. Locate posts no further than 4' on center at equal distances.
- d. **Infill panels:** 1 x 19 type weave, 3/16" stainless steel horizontal rope cables in SS316 alloy at 3 1/4" on center. Provide tensioners at ends and other locations as required to maintain a tight horizontal look with no cable deflection between verticals.
- e. **Finish:** # 4 brushed stainless steel.
- f. **Power:** N/A.
- g. **Lighting:** N/A.
- h. **Below Staircase Base (Cane) Railing:** N/A.
- i. **Height:** 42" to top of guardrail. Refer to drawings and TAS requirements for handrail heights.

2.8 Smoke Barrier Curtain

A. Draft Curtain at Main Stair 3STRW4:

- 1. *Basis of Design: Viva Modular Railing Systems, 1454 Halsey Way, Carrollton, TX 75007, Ph. 972.353.8482. "Smoke Baffle System (SBS)", 18" tall exposed height x 1/2" tempered glass w/SBS-2, concealed clamp mounting. (Addendum #10)*

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

2.9 06 20 23 Interior Finish Carpentry: Refer to "INTERIOR FINISH SPREADSHEET (Addendum #10)."

A. Stain Grade Wood Millwork and Trim:

- 1. **Species:** Select American Cherry AWI Premium Grade A wood to match Architect's sample.
- 2. **Cut & Grain:**
 - a. **Select American Cherry:**
 - 1) 80% sap free on finish side of wood
- 3. **Finish:** Shop (paint booth) applied oil based stain with catalyzed lacquer finish; level 80 sheen to match Architect's sample. Refer 09 91 00 and Architect's Finish Selection Summary Spreadsheet. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
 - a. Project requires the highest quality millwork finish available with finish applied at a millwork shop in a paint booth, not field applied.
 - b. **Approved hardwood suppliers:**
 - 1) The Wood Gallery – 10724 Goodnight Ln., Dallas 75220, ph. 972.869.9161
 - 2) Dakota Hardwoods – 641 W. Mockingbird Ln., Dallas, TX 75247, ph. 972.677.7437, contact: Scott Brant
 - 3) Substitutions – to be approved by Architect.

- c. **Approved finishers:**
 - 1) Submit qualifications and samples of work from proposed finishing sub for Architect approval.
 - 4. **WP-4: 4" Stain Grade Wood Chairrail – TWC # CH066.** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
- B. **Paint-Grade Millwork and Trim:**
 - 1. **Species:** Poplar above 8' AFF; Maple below 8' AFF.
 - 2. **Finish:** Oil based enamel sprayed-on finish including final touchup (no brush marks; no exceptions!). Refer 09 91 00.
 - 3. **Color & Sheen:** Refer to Architect's Finish Selection Summary Spreadsheet. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
- C. **Stain Grade Wood Micro-Perforated Acoustical and Non-Perforated Wood Paneling (for use on East Atrium/Lobby 100 walls):** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
 - 1. **Basis of Design:** Architectural Components Group, Inc. Marshfield, MO, Ph. 417.869.6777. Local Rep., Blake Peterson of Designed Performance Associates, Richardson, TX, Ph. 972.381.9100.
 - 2. Other manufacturers' products of equal quality will be considered by the Architect. Submit substitution request.
 - 3. **Acceptable Product:** SS1-1215-C Quarter Sawn Cherry. Matching wood panels to match Architect's sample with and without micro-perforations/acoustical backing at locations indicated on drawings.
 - 4. **Species & Finish:** Quarter Sawn Select American Cherry stained and with clear satin sheen to match Architect's sample; turn grain vertically.
 - 5. **Perforation Pattern:** Offset pattern to be selected by Architect from manufacturer's full and complete product lines and patterns.
 - 6. **Perforation:** .05 mm holes spaces 1.9 mm on center offset.
 - 7. **Overall Perforated Acoustical Panel Thickness:** 2 inches
 - a. Thickness of Wood Panel: 3/4 inches
 - b. Thickness of Acoustical Backing: 1 1/2 inches
 - 8. Provide light gage metal framing, blocking and shims as required to install panels and align face of acoustical panels with non-acoustical panels
 - 9. **AWI Quality Level Required:** Premium Grade
 - 10. **Panel Sizes:** Refer to drawings.
 - 11. **Acoustical Backing:** Factory attach to back of panels.
 - 12. **Fire Rating:** Class 1(A)
 - 13. **FSC Certification Requirement:** none required.
 - 14. **Construction:** No urea formaldehyde allowed in the construction of panels.
 - 15. **Attachment:** Standard Z clips.
- D. **Wood Paneling and Flooring at Learning Stair**
 - 1. **Species:** American Cherry to match Architect's sample.
 - 2. **Grade:** AWI premium grade.
 - 3. **Risers:** Veneered 3/4" plywood.
 - 4. **Treads:** Matching 25/32" random length tongue and groove wood flooring.
 - 5. **Finish:** Match Architect's sample. Provide appropriate clear coat finish and thickness for heavy foot traffic. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

2.10 06 41 00 Custom Casework: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. **Stain Grade Wood Casework:** meet same requirements including shop (paint booth) finishing (not field applied) as stipulated in 06 20 23 Interior Finish Carpentry.
- B. **Plastic Laminate:**
 - 1. **Laminate:** Refer to Section 06 41 00.
 - 2. **Products:** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

3. **Sheen:** to be selected by the Architect from the full line of sheens available from any of the manufacturers listed in this section. Refer to Architect's Finish Selection Summary Spreadsheet. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
 4. **Quality:** AWI Custom Grade.
- 2.11 06 61 16 Solid Polymer Fabrications:** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
- A. **Material Only Allowance:** \$35/SF
 - B. **Thickness:** 3 CM
- 2.12 06 82 13 Glass Fiber Reinforced Plastic Paneling:** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
- A. **Basis of Design:** Marlite
 - B. **Fire Rating:** Fire rated paneling and trim meeting Class I/A and Low Flame/Low Smoke (LF&S) requirements of ASTM E84.
 - C. **Color:** Bright white # P 199
 - D. **Surface:** Pebbled
 - E. **Trim:** Match color and type for specified paneling.
 - F. Refer Section 06 82 13 and Architect's Finish Selection Summary Spreadsheet.

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

- 2.1 07 18 23 Floor Waterproofing**
- A. Refer to Section 07 18 23 and drawings.
 - B. **FW-P:** Provide and install at penthouse floor and dropped mechanical room floors at northeast quadrant of building.
 1. **Color:** to be selected by Architect from manufacturer's full and complete lines of colors. *Refer to INTERIOR FINISHES SPREADSHEET (Addendum #10).*
- 2.2 072423 – Direct Applied Finish System**
- A. *Refer to 07 24 23 and drawings.*
 - B. *Provide and install at exterior exposed soffits of colonnades and other locations as indicated on drawings.*
 - C. *Finish: Ultra-smooth.*
 - D. *Color: White as approved by Architect.*
- 2.3 07 32 13 Clay Roof Tiles**
- A. Refer to Section 07 32 13 and drawings.
 - B. **Basis of Design:** Ludowici Spanish Clay Tiles, New Lexington, OH, ph. 800.945.8453, local contact, Peter Heinz, Tola Architectural Sales, Ph 214.770.0895.
 1. **Acceptable Product:** Ludowici 13 ¼" Full Cornered Spanish-S high profile tile with single barrel design which provides a distinctive ripple pattern across the roof.
 2. **Nominal Size:** 9.75 inches wide x 13.25 inches long. Average exposure 8.25 inches center to center by 10.25 inches long.
 3. **Colors:** custom weathered reddish clay mixture with smooth textured finish to **match Spanish tile roof on the existing Hardin Administration Building.** The intent is to match the existing weathered appearance of the Hardin Building clay tile roof with new tile utilizing antiquing treatments on the new Health Science Center.
 4. **Fire Rating:** Class A with Ludowici Pro 70 underlayment over min. 40 mil WR Grace Ice and Water Shield HT.
 5. **Accessory Tile Pieces:** as recommended by manufacturer including full corner eave tile, eave closure tile, top fixture tile, end band tile, detached gable rake tile, circular cover hip tiles, circular cover ridge tile and circular cover ridge end tiles.

6. **Mockup:**
 - a. **Initial:** 100 SF of tiles laid on the ground for initial selection and positioning
 - b. **Final:** 100 SF of tiles on an elevated sloped roof mockup with the specified substrate, underlayment and final trim pieces for Architect's final approval.

2.4 07 42 13 Metal Wall Panels (*Previous Prefinished Uninsulated Metal Panels is deleted.*)

- A. *Refer to Section 07 42 13 and drawings.*
- B. *Basis of Design for Prefinished Perforated Screenwall for Rooftop AHU's. Confirm final panel layout with Architect prior to ordering and preparing shop drawings.*
 1. *MP – 1: Centria Ecoscreen Ecolap ¾" Perforated Wall Panel.*
- C. *Finish: To be selected by Architect from one of the following:*
 1. *High performance organic two coat 70% fluoropolymer painted finish.*
 2. *Class I Clear Anodized aluminum finish.*
- D. *Color: To be selected by Architect from manufacturer's full and complete lines of colors including metallic and mica colors. (Addendum #9)*

2.5 07 42 29 Terra Cotta Rainscreen Cladding: *This section is deleted. (Addendum #10)*

2.6 07 42 44 Composite (Aluminum) Wall Panels: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. *Refer to Section 07 42 44 and drawings.*
- B. **Basis of Design:** Rainscreen Rout and Return Dry-Seal System for installation at exterior of curved east atrium walls (exterior application) and at elevator shaft enclosure in the Atrium (interior application).
 1. **MP-5 (for exterior applications):** Alpolic/HD/fr (heavy duty/fire retardant) as required by code.
 - a. **Aluminum Skin Thickness:** .032"
 - b. **Core:** type FR (fire resistive)
 2. **MP-6 (for interior applications):** Alpolic/fr/PE (fire retardant) as required by code.
 - a. **Aluminum Skin Thickness:** .020"
 - b. **Core:** type PE (polyethylene)
- C. **Colors:** To be selected by Architect from manufacturer's full and complete lines of colors including metallic and mica colors. Generally, the Architect's design intent is to select a white color on the exterior and a silver metallic color for the interior locations.
- D. **Joint and Reveal Size:** 5/8" wide x 1" deep reveals fabricated in color to match panels. Final reveal size to be confirmed between Architect and selected fabricator.
Panel Finish: High performance organic two coat 70% fluoropolymer painted finish at exterior white panels and metallic silver finish at interior locations.

2.7 07 52 16 Modified Bituminous Membrane Roofing: *This section is deleted. (Addendum #10).*

2.8 07 54 00 Thermoplastic Membrane Roofing:

- A. *Refer to Section 07 54 00 and drawings.*
- B. *Color: White.*

2.9 07 62 00 Sheet Metal Flashing and Trim

- A. *Refer to Section 07 62 00.*
- B. **Basis of Design:** Peterson Pac-Clad
- C. **Finishes:**
 1. **At Clay Tile Roof:** Copper.
 2. **All other Locations:** High performance organic two coat 70% fluoropolymer painted finish.
- D. **Colors:**

1. **At locations exposed to view:** To be selected by Architect from manufacturer's full and complete lines of all available finishes including upgraded metallic and mica finishes. Generally, Architect anticipates the colors to match the adjacent materials.
2. **At locations not exposed to view:** Silver or white to match adjacent materials.

2.10 07 71 00 Manufactured Roof Specialties

- A. Refer to Section 07 71 00.
- B. **Basis of Design:**
 1. **Prefinished Metal Copings:** Pac-Tite tapered coping by Pac-Clad/Peterson
 - a. **Finish:** High performance organic two coat 70% fluoropolymer painted finish.
 2. **Gutters, Collection Boxes, Downspouts and Flashing Associated with Clay Tile Roof:**
 - a. **Finish:** Copper

2.11 07 81 23 Intumescent Fireproofing: *This section is deleted. (Addendum #10)*

2.12 07 92 00 Joint Sealants

- A. **Finishes:**
 1. **Joints in counter tops and between counter tops and adjacent materials:** Custom color to match countertop material. Verify color with Architect prior to ordering sealant material.
 2. **Joints in masonry:** Custom color to match adjacent brick, terra cotta or cast stone. Verify final color with Architect on mock-up.
 3. **Joints between aluminum door and window frames and adjacent materials:** Custom color to match color of aluminum frame.
 4. **Other joint sealant colors:** Match color of adjacent materials with custom color sealant as required. Verify colors with Architect prior to installation.
- B. **Samples:** Submit actual samples to Architect for approval prior to installation.

2.13 07 95 00 Expansion Control (Not Used)

DIVISION 08 – DOORS AND WINDOWS

2.14 08 11 13 Hollow Metal Doors and Frames

- A. Refer Sections 08 11 13 and 09 91 00.
- B. **Finish:**
 1. Galvanized G90 primer.
 2. **Oil based enamel paint.** Spray-paint only, including touch-up paint (do not brush; no exceptions!).
- C. **Color:** Refer to Architect's Finish Selection Summary Spreadsheet.

2.15 08 12 16 Interior Aluminum Frames (for interior locations other than those at the atrium)

- A. **Finish:**
 1. Clear anodized, Class II aluminum finish
 2. Note: Refer to Section 08 41 13 for finish on storefront at entry vestibules of Lobbies.

2.16 08 14 16 Flush Wood Doors

- A. **Species:** Select American Cherry to match Architect's sample.
- B. **Finish:** Stain to match Architect's sample.
- C. **Cut:** Plain sliced to match Architect's sample
- D. **Grade:** AWI Premium Grade.

2.17 08 31 13 Access Doors and Frames

- A. Refer Sections 08 31 13 and 09 91 00.
- B. **At Restroom and exterior walls:** Polished stainless steel.
- C. **All other locations:**
 - 1. **Factory finish:** Prime painted with field applied painted finish.
 - 2. **Field finish:** Spray-painted with oil-based enamel to match adjacent wall or ceiling.

2.18 08 34 80 Automatic Overhead Coiling Fabric Smoke Curtains: *This section is deleted. (Addendum #10)*

2.19 08 41 13 Aluminum-Framed Entrances and Storefronts (for covered entrances, exterior doors and ALL interior glazed frames in the atrium)

- A. **Frame Finish:** Clear anodized, Class I aluminum finish
- B. **Finish for exposed hardware:** # 4 brushed stainless steel or polished chrome (verify with Architect prior to ordering).

2.20 08 41 26 All-Glass Entrances and Storefronts: *This section is deleted (Addendum #10)*

2.21 08 44 13 Glazed Aluminum Curtain Walls

- A. **Frame Finish:** Clear anodized, Class I aluminum

2.22 08 45 11 Translucent Linear Channel Glazing System

- A. **GL-7: Basis of Design:** Pilkington Profilit K25/60/7 Dual Channel Glazing System for exterior applications. Supplied by Technical Glass Products, Snoqualmie, WA, Ph. 800.426.0279.
 - 1. **Face Width:** K25 - 10.31"
 - 2. **Flange Height:** 2.36"
 - 3. **Glass Thickness:** .28"
 - 4. **Color Coating:** Amethyst (slight blue transparent)
 - 5. **Surface Texture:** Clear translucent (submit samples for final selection)
 - 6. **Coating:** Low-E
 - 7. **Insulation:** 16 mm Lumira aerogel insulation
 - 8. **U-Value:** .19
 - 9. **Light Transmission:** 70%-75%
 - 10. **Solar Heat Gain Coefficient:** .31
 - 11. **STC Rating Required:** STC 44
 - 12. **Frame:** Thermally broken aluminum perimeter frame
 - 13. **Glazing Type:** Tempered,
 - 14. **Connections:** Concealed type

2.23 08 71 00 Door Hardware

- A. Refer Section 08 71 00
- B. **Finish:**
 - 1. **Exterior Hardware:** To be selected by Architect from one of the following:
 - a. # 4 brushed stainless steel
 - b. Clear anodized, Class I or thicker
 - c. Satin nickel.
 - 2. **Interior Hardware:** To be selected by Architect from one of the following:
 - a. # 4 brushed stainless steel
 - b. Clear anodized, Class I or thicker

2.24 08 71 13 Automatic Door Operators

- A. **Finish:** Door operator cover finish to match Aluminum Entrances and Storefront frame finish.

2.25 08 80 00 Glazing

- A. Refer Section 08 80 00 and drawings.
- B. **Exterior Glazing & Building Entrances Basis of Design – 1" Insulated Panels: Vitro PPG Solarban 90 XL.**
 - 1. **GL-1 (Exterior Insulated Vision Panels):**
 - a. **Exterior Lite:** ¼ inch thick Solarban 90XL
 - b. **Interior Lite:** ¼ inch thick clear
 - c. **Glass Tint:** To be selected by Architect from manufacturer's full and complete line of tinted glass products.
 - d. **Air Space:** 1/2 inch
 - e. **Coating:** Low-E on second surface.
 - f. **SHGC:** 0.23
 - g. **VLT:** 51%
 - h. **Exterior Reflectance:** 12%
 - i. **U-Value (winter):** 0.29
 - 2. **GL-2 (Exterior Insulated Vision Panels with Ceramic Frit or Etched Pattern):**
 - a. **Exterior Lite:** ¼ inch thick Solarban 90XL.
 - b. **Interior Lite:** ¼ inch thick clear.
 - c. **Glass Tint:** To be selected by Architect from manufacturer's full and complete line of glass products.
 - d. **Ceramic Frit or Etched Pattern:** Ceramic "Line" frit or etched pattern finish on surface number to be selected by the Architect. Confirm dimensions, pattern and color of ceramic frit or etching with Architect prior to fabrication.
 - e. **Air Space:** 1/2 inch
 - f. **Coating:** Low-E on second surface.
 - g. **SHGC:** 0.23
 - h. **VLT:** 51%
 - i. **Exterior Reflectance:** 12%
 - j. **U-Value (winter):** 0.29
 - 3. **GL-3 (Exterior Insulated Spandrel Panels):**
 - a. **Exterior Lite:** ¼ inch thick Solarban 90XL.
 - b. **Interior Lite:** ¼ inch thick clear.
 - c. **Glass Tint:** To be selected by Architect from manufacturer's full and complete line of glass products
 - d. **Ceramic Frit or Etched Pattern:** Ceramic "Line" frit or etched pattern finish on surface number to be selected by the Architect. Confirm dimensions, pattern and color of ceramic frit or etching with Architect prior to fabrication.
 - e. **Air Space:** 1/2 inch
 - f. **Coating:** Low-E on second surface.
 - g. **SHGC:** 0.23
 - h. **VLT:** 51%
 - i. **Exterior Reflectance:** 12%
 - j. **U-Value (winter):** 0.29
 - 4. **Note:** Provide tempered glazing only where required by code and heat strengthened glazing in all other locations. Do not use tempered glass at restroom glazing where drywall inside is painted black or where spandrel frit is a dark color.
 - 5. **Performance Characteristics:**
 - a. **Visible Light Transmittance:** 51 percent
 - b. **Outside Light Reflectance:** 12 percent
 - c. **Winter Nighttime U-Value:** 0.29
 - d. **Summer Daytime U-Value:** Manufacturers standard
 - e. **Shading Coefficient:** 0.27
 - f. **Solar Heat Gain Coefficient:** 0.23
- C. **Interior Glazing Units:**
 - 1. **GL-4 (Interior 1" Insulated Acoustical Panels):**

- a. **Exterior Lite (atrium side):** 1/4 inch thick clear tempered glass.
- b. **Interior Lite (instruction side):** 1/4 inch thick clear laminated safety glass.
- c. **Air Space:** 1/2 inch
- 2. **GL-5 (Interior Spandrel Glass Panels):**
 - a. **Glass Lite:** 1/4 inch thick clear tempered glass. Provide **high iron content glass** with a slight greenish cast.
 - b. **Ceramic Frit or Etched finish:**
 - 1) Apply to second surface.
 - 2) **Color:** To be selected by Architect from manufacturer's full and complete line of colors. General intent is to provide a white ceramic frit or etching which, when combined with the heavy iron content glass, will result in a greenish-white colored glass.
- 3. **GL-6 (Decorative Laminated Safety Glass for use at base of open elevator shaft in Atrium).** *This glazing is deleted (Addendum #10)*
- 4. **GL-8 (Leaded Glass):** 1/16" lead shielded glass for Radiology Rooms 231, 232, 233, 234, and 235.

2.26 08 87 33 Decorative Glazing Film: *This section is deleted (Addendum #10).*

2.27 08 91 00 Louvers

- A. **Finish:**
 - 1. High performance organic two coat 70% fluoropolymer painted finish.
 - 2. Custom color to be selected by Architect. Architect's general intent is to match the adjacent materials louvers are installed in.

DIVISION 09 - FINISHES

2.28 09 29 00 Gypsum Board

- A. Refer to Section 09 29 00, drawings and Architect's Finish Selection Summary Spreadsheet.
- B. **Wall Texture:**
 - 1. Light orange peel. Submit samples for Architect review.
 - 2. *Locations receiving W.WS Writable Surface Paint are to have a minimum level 4 finish texture. (Addendum #10).*
- C. **X-ray Room Lead Shielding:** Per the Owner's Physicist Report, provide 1/16" thick lead lined Gypsum Wall Board to 7' AFF on all walls in each of the five energized X-ray Rooms in Radiological Sciences on the second floor. Where there is a demising wall between two X-ray rooms, lead lined GWB only needs to be applied to one side of the demising wall.

2.29 09 30 00 Tiling

- A. **Tile Products:** *Refer to INTERIOR FINISHES SPREADSHEET (Addendum #10) for specific tile selections.*
 - 1. **CT-1:** \$12/SF material only allowance
 - 2. **CT-2:** \$12/SF material only allowance
 - 3. **CT-3:** \$12/SF material only allowance
 - 4. **CT-4:** \$12/SF material only allowance
 - 5. **CT-5:** \$12/SF material only allowance
 - 6. **CT-6: (Mosaic Wall Tile):** Preliminary selection - Daltile Caprice Series F172 "Crimson Blend" 12 x 12. For GMP Include \$30/SF material only allowance for mosaic wall tile.
 - 7. *B.CT.01: as selected by Architect. Refer to spreadsheet (Addendum #10).*
 - 8. *B.CT.03: as selected by Architect. Refer to spreadsheet (Addendum #10).*
- B. **Grout:**
 - 1. **Floor Tile:** Epoxy grout.
 - 2. **Wall Tile:** Sanded grout.

3. Colors to be selected by Architect from any manufacturer listed in the specifications full and complete lines of products, including designer colors.
- C. **Tile Trim pieces:** as required by Architect to match floor and wall tile.
- D. **Joint Size:** Not to exceed 1/16" wide maximum unless otherwise approved by Architect. Confirm with manufacturer and Architect prior to installation.

2.30 09 51 13 Acoustical Panel Ceilings: Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).

- A. **ACT-1:** Armstrong World Industries; "TechZone" # 3256
 1. **Tile Product:** Optima
 2. **Tile Panel Size:** 48 x 48 x 1 inches and other sizes (refer to drawings)
 3. **Technical Zone Size:** 6 inches wide (refer to drawings)
 4. **Color:** White Diamond.
 5. **Edge:** Square Tegular.
 6. **Grid:** 9/16 inch Interlude XL.
 7. **NRC (Sound Absorption):** 0.95
 8. **AC (Articulation Class):** 190
 9. **CAC (Sound Blocking):** 26
 10. **Light Reflectance:** 90%
 11. **Fire Performance:** Class A (UL)
 12. **Material:** DuraBrite Scrim surface with mineral fiber backing
- B. **ACT-2:** Armstrong World Industries; Dune # 1775.
 1. **Size:** 24 x 24 x 5/8 inches.
 2. **Color:** White Diamond.
 3. **Edge:** Beveled Tegular.
 4. **Grid:** Suprafine 9/16 inches.
 5. **NRC (Sound Absorption):** 0.50
 6. **AC (Articulation Class):** 170
 7. **CAC (Sound Blocking):** 35
 8. **Light Reflectance:** 83%
 9. **Fire Performance:** Class A (UL)
 10. **Material:** Mineral fiber
 11. **Surface Finish:** Factory applied latex paint
- C. **ACT-3:** Armstrong World Industries; Cortega #770 for non-fire rated applications and #824 for fire rated applications.
 1. **Size:** 24 x 24 x 5/8 inches.
 2. **Color:** White Diamond.
 3. **Edge:** Square Lay-In.
 4. **Grid:** Prelude XL 15/16 inch for non-fire rated applications and XL Fire Guard for fire rated applications.
 5. **NRC (Sound Absorption):** 0.55
 6. **AC (Articulation Class):** N/A
 7. **CAC (Sound Blocking):** 35
 8. **Light Reflectance:** 82%
 9. **Fire Performance:** Class A (UL)
 10. **Material:** Mineral fiber
 11. **Surface Finish:** Factory applied latex paint
 12. **Recycled Content:** 43%
- D. **ACT-4 (for use at Grand Stair soffit above the first floor level):** Painted Perforated Metal Panels with 1/8" reveals on all edges.
 1. **Acceptable Manufacturer:** Gordon, Inc., Bossier City, LA, Ph. 800.747.8954
 2. **Acceptable Product:** Aluma Vault 3000E
 3. **Size:** Refer to drawings.

4. **Perforation Pattern:** 1 ½" unperforated borders around the perimeter of each panel with perforations occurring inside of border. Perforation pattern to be selected by Architect from manufacturer's full and complete perforation options.
5. **Method of Attachment:** Torsion Spring
6. **Color:** Custom paint color to be selected by Architect. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
7. **Finish:** Factory applied high performance organic two coat 70% fluoropolymer painted finish.
8. **Edge:** 1/8" painted reveals to match panels.

2.31 09 65 13 Resilient Base and Accessories *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. Refer to section 09 65 13 for full specification.
- B. **Resilient Base:**
 1. **RB-1:** 4" Cove base.
- C. **Colors:** To be selected by Architect from any manufacturer listed in this section's full and complete lines of all available finishes including upgraded colors and finishes.

2.32 09 65 16 Resilient Sheet Flooring: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. **Basis of Design:**
 1. **Approved Product:** Forbo, Marmoleum Real Series. Other manufacturers' products of equal quality will be considered by the Architect.
 2. **Size:** 32M x 200CM;
 3. **Color:**
 - a. **RS-1 (field color):** "Serene Grey" 3146
 - b. **RS-2 (accent color):** "Lava" 3139
 - c. **RS-3 (accent color):** "Fresno Blue" 3055
 - d. **RS-4 (accent color):** "Dove Blue" 3053
 - e. Other colors as selected by Architect from manufacturer's full and complete color and product lines.

2.33 09 65 19 Resilient Tile Flooring: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. **Luxury Vinyl Tile (LVT):**
 1. **Material only allowance:** \$10/SF
 2. **Products and Colors:** To be selected by Architect.

2.34 09 65 66 Rubber Flooring: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. **Basis of Design:** Norament Round by Nora Flooring with raised coin shaped profiles on horizontal surfaces and Norament Stair treads for use in the 3 fire stairs on the project.
- B. **Colors:**
 1. **RF-1:** Preliminary selection Norament Round # 0882, "Platinum Gray" or approved equal. Final color to be selected by Architect from manufacturer's full and complete color lines including premium colors.
 2. Other colors as selected by Architect from manufacturer's full and complete color and product lines.
- C. **Size:** 19.72" (501mm) x 19.72" x .13" (3.2mm)

2.35 09 66 23 Resinous Matrix Terrazzo Flooring: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. **Colors and aggregate:**
 1. **TR-1:** Color and aggregate to match Architect's sample
 2. **TR-2:** Color and aggregate to match Architect's sample

3. **TR-3:** Color and aggregate to match Architect's sample
 4. **TR-4:** Color and aggregate to match Architect's sample
 - a. Other colors and aggregates as selected by Architect from manufacturer's full and complete color and product lines.
 - B. **Pattern/Design:** Refer to drawings. Provide shop drawings for Architect approval.
 - C. **Metal Dividers:** 1/32" 1/16" and 1/8" zinc. Use double back to back 1/32" wide dividers at control joints
 - D. **Flooring:** 3/8" thick poured epoxy.
 - E. **Base, Stair Treads and Risers:** 3/4 inch thick precast units to match floor. Base shall not be less than 10' sections. Refer to drawings for patterning.
 1. Install 3 abrasive strips on leading edge of each tread. Ref 09 66 23.
- 2.36 09 68 13 Tile Carpeting:** *Refer to INTERIOR FINISHES SPREADSHEET (Addendum #10).*
- A. **Carpet Tile applied with Adhesive Discs (do not use adhesive):**
1. **CPT-1:** Shaw Contract Custom Carpet
 - a. **Collection:** "Beyond the Fold"
 - b. **Style:** "Folded Edge Tile" 5T062
 - c. **Custom Sample Number:** X078S-0; request date April 28, 2017
 - d. **Color Reference:** Paprika 00157 and "Sundried Ecru" matching custom sample number above.
 - e. **Colors Listed on Sample:** A:C1644; B:CJ118; C:6180; D:5652D
 - f. **Size:** 18" x 36" plank
 - g. **Weight:** 24 oz.
 - h. **Backing:** Ecoworx
 - i. **Installation Method:** Confirm in field with Architect. It is anticipated that a monolithic pattern will be utilized using mixed plank products specified in this section as well as others from this and related collections.
 2. **CPT-2:** Shaw Contract
 - a. **Collection:** "Beyond the Fold"
 - b. **Style:** "Expand Tile" 5T059
 - c. **Color:** "Ecru"59105
 - d. **Size:** 18" x 36" plank
 - e. **Weight:** 24 oz.
 - f. **Backing:** Ecoworx
 - g. **Installation Method:** Confirm in field with Architect. It is anticipated that a monolithic pattern will be utilized using mixed plank products specified in this section as well as others from this and related collections.
 3. **CPT-3:** *Not Used, Addendum #10)*
 4. **CPT-4:** Shaw Contract Custom Carpet
 - a. **Collection:** "Beyond the Fold"
 - b. **Style:** "Folded Tile" EW18x36
 - c. **Custom Sample Number:** X434Y-0; request date July 28, 2017
 - d. **Color Reference:** *"Sundried Ecru" matching custom sample number above. (Addendum #10)*
 - e. **Colors Listed on Sample:** A:C1644; B:CJ118; C:6180; D:5652D
 - f. **Size:** 18" x 36" plank
 - g. **Weight:** 24 oz.
 - h. **Backing:** Ecoworx
 - i. **Installation Method:** Confirm in field with Architect. It is anticipated that a monolithic pattern will be utilized using mixed plank products specified in this section as well as others from this and related collections.
 5. **CPT-5:** *Not Used, Addendum #10)*
 6. **CPT-6:** Shaw Contract Custom Carpet
 - a. **Collection:** "Beyond the Fold"
 - b. **Style:** "Folded Tile" EW18x36

- c. **Custom Sample Number:** X436Y-0
- d. **Color Reference:** Shimmer, Ecru
- e. **Colors Listed on Sample:** A:C1644, B:CJ118, C:6180, D:5790D
- f. **Size:** 18" x 36" plank
- g. **Weight:** 24 oz.
- h. **Backing:** Ecoworx
- i. **Installation Method:** Confirm in field with Architect. It is anticipated that a monolithic pattern will be utilized using mixed plank products specified in this section as well as others from this and related collections.
- 7. **CPT-7:** To be selected by Architect. Provide material only allowance of \$32/SY.
- 8. **WT-1: Walk off carpet tile: (Addendum #10)**
 - a. **Manufacturer:** Milliken,
 - b. **Collection:** "Quadrus"
 - c. **Pattern:** Gravity
 - d. **Color:** Streamline
 - e. **Color #:** GRA118-119
 - f. **Size:** 24"x24"

2.37 09 72 00 Wall Covering: Refer to 12 30 00 Alternates and INTERIOR FINISH SPREADSHEET, (Addendum #10).

- A. Refer to Section 09 72 00 and drawings
- B. **Basis of Design:** Tri-kes Digital Graphic wall covering.
- C. **Location:** Atrium 100, north wall first floor.
- D. **VWC Material & Graphic Design Assistance Allowance:** \$15/SF + \$1,000 for graphic design assistance.
- E. **Initial Digital Graphics Design and File:** To be provided by Architect.

2.38 09 77 63 Digital Graphic Wall Panels: Refer to 12 30 00 Alternates, (Addendum #10).

- A. Refer to Section 09 77 63 and drawings
- B. **Basis of Design:** Koroseal Interior Products
 - 1. **Series:** Digital Print Media
 - 2. **Panel Type:** Acrylic
- C. **Location:** West Atrium east wall first and second floor. Floor to ceiling digital graphic panels.
- D. **Basic Digital Graphics Design and File:** To be provided by Architect. Additional graphic design assistance will be required by the manufacturer.
- E. **Mounting Method:** Lumaline Flex-Display.
- F. **Size:** refer section 09 77 63.
- G. **Material only allowance:** \$45/SF.

2.39 09 84 36 Fabric Wrapped Acoustical Wall Units

- A. **Thickness:** 2 inches thick.
- B. **Reveals:** Refer to drawings for locations.
- C. **Fabric Material Only Allowance:** \$42/SY
- D. **Location:** Dean's Conference Room walls from top of chairrail to bottom of ceiling.

2.40 09 91 00 Painting

- A. **Acceptable Manufacturers:**
 - 1. Sherwin Williams
 - 2. Glidden
 - 3. Kelly Moore
 - 4. PPG Industries
- B. **Colors: Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10)**
 - 1. **PT-1:** Sherwin Williams; **Color:** SW9170 "Acier"

2. **PT-2:** Sherwin Williams; **Color:** to match SW1901 "Glamorous White"
 3. **PT-3:** Sherwin Williams; **Color:** *SW7607 "Santorini Blue"*
 4. **PT-4:** Sherwin Williams; **Color:** *SW2802 Rockwood Red"*
 5. **PT-5:** Sherwin Williams; **Color:** *SW2811 Rockwood Blue Green"*
 6. **PT-6:** Sherwin Williams; **Color:** SW7046 "Anonymous"
 7. **PT-7:** *Sherwin Williams, Color: SW9112 "Song Thrush"*
 8. **PT-8:** *Sherwin Williams, Color: To Be Determined*
- C. **Staining:** All staining to be performed in controlled conditions in millwork shop paint booth by highly qualified millwork finishers. Staining shall **NOT** be done in the field (no exceptions). Staining shall match Architect's control samples.
- D. **Dry Erase Walls:** Sherwin Williams Dry Erase Coating over two coats of flat latex and primer coat. Install per manufacturer's recommendations.
1. **W.WS:** *Color same as PT-1. See above and refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
 2. *Locations receiving W.WS Writable Surface Paint are to have a minimum level 4 finish texture.*

2.41 09 97 13 Steel Coatings

- A. **Epoxy Colors:** Custom colors to be selected by Architect.

DIVISION 10 - SPECIALTIES

2.42 10 11 03 Visual Display Boards

- A. **Glass Dry-Erase Markerboards:**
1. **GL-8:** Clarus, Glass Float Series; **Color:** "Pure White" # C100. Provide a quantity of (1) in a location to be determined.
- B. **Porcelain Dry-Erase Markerboard:**
1. **Rails and Frames:** Clear anodized.
 2. **Markerboard Surface:** Bright white semi-gloss finish.
 3. Provide at locations called for on plans.
- C. **Cabinet White Boards**
1. **Cabinet Finish:** American Cherry.
 2. **White Board:** Bright white semi-gloss finish
 3. **Tackboard Fabric:** Color to be selected from manufacturer's full and complete lines of all fabrics and products including premium grades.
 4. Provide one at Dean's Suite at location to be determined.
- D. **Vinyl Dry Erase Wall Covering**
1. **Finish:** Bright white, semi-gloss finish, non-magnetic type.
 2. **Installation:** Install over 20 ga. sheet metal fully adhered to wall for magnetic properties.
 3. Provide at locations called for on plans.
- E. **Glass Enclosed Display Case**
1. **Size:** 30"T x 36"W x 4"D
 2. **Finish:** Clear glass with clear anodized Class I finish.
 3. **Location:** Confirm final location with Architect at Atrium Lobby

2.43 10 14 00 Signage

- A. Refer to section 10 14 00 and drawings.
- B. **Colors:** To be selected by Architect
- C. **Signage Design:** refer to drawings
- D. **Handicap Parking Sign Frame & Metal Mesh Finish:** Powder coated frame and metal mesh with blue and white signage.
- E. **Building Plaques:** Bronze pebbled background with raised satin bronze copy and border. Refer to signage drawings for sizes. Provide (2) in the building: one at west Atrium and one at southeast vestibule.

- F. **Monument Sign:** Campus standard. Relocate existing monument sign from demolished MaGaha Building. Re-letter and refurbish as required to meet campus standard requirements. Provide ground mounted flood light on each of the (2) long sides of sign with required power and circuiting, connect to BMS system.

2.44 10 21 13 Stainless Steel Toilet Compartments

- A. Refer to section 10 21 13 and drawings.
B. **Basis of Design:** Hadrian, Inc., Mentor, OH, Ph. 800.536.1469.
C. **Style:** No Sight Line, Standard Series, floor mounted overhead braced partitions.
D. **Finish:** # 4 brushed stainless steel
E. **Design:** Zero sight lines. **No gaps between panels.**

2.45 10 21 23 Cubicle Curtains and Tracks:

- A. Refer to section 10 21 23 and drawings.
B. Basis of Design: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

2.46 10 22 26 Operable Partitions: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. Refer to section 10 22 26 and drawings.
B. **Basis of Design:**
1. **Partition:** Modernfold Acousti-Seal 931 Single Panel Series.
2. **Operation:** Manual.
3. **STC:** 52 min.
4. **Location:** Between Dental Lab Classrooms 103A and 103B.
5. **Finishes:** COM fabric with material only allowance of \$42/SY. Metal trim shall be manufacturer's painted finish, color to be selected by Architect from manufacturer's full and complete lines including premium colors.

2.47 10 26 13 Wall and Corner Guards: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. Refer to section 10 26 13 for products and drawings for locations.
B. **Corner Guard Products:**
1. **WP-1 (Corner Guard):** 1 ½" x 1 ½" x 60"H angle; # 4 brushed stainless steel finish.
2. **WP-2 (End Wall Protector):** channel sized to encapsulate end of wall x full height fo wall; # 4 brushed stainless steel finish.
3. **WP-3 (Vinyl Wall Guard Railing):** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
4. **WP-4 (Wood Chairrail):** 4"H continuous American Cherry chairrail. Refer to drawings for profile and Section 06 20 23. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

2.48 10 28 13 Toilet Accessories

- A. **Finish:** Stainless steel # 4 finish or polished chrome. Refer to 10 28 13

2.49 10 44 00 Fire Protection Specialties

- A. **Recessed FEC Cabinet Door and Trim Finish:** Stainless steel # 4 finish on door with red lettering and clear glass.
B. **Knox Boxes:**
1. **Type:** as required by local fire marshal
2. **Number and locations:** Provide one box at the west Atrium vestibule entrance and the second at one of the east vestibule entrances to the building as determined by the local fire marshal.

2.50 10 51 23 Plastic Laminate Clad Lockers

- A. **Finish:** Plastic laminate cladding to be selected by Architect from any major laminate manufacturer listed in section 064100. Sheen to be selected from manufacturer's full and complete line of sheens.

2.51 10 81 13 Bird Control Devices

1. **Basis of Design:** Bird-B-Gone metallic spike type. Provide a minimum of 500 LF of installed product in locations as directed by Architect.

2.52 10 821 23 Grilles: *This section is deleted, (Addendum #10).*

DIVISION 11 - EQUIPMENT

2.53 11 31 00 Residential Appliances

- A. **Finish:** # 4 brushed stainless steel finish with black trim.

2.54 117300 Patient Care Equipment

- A. **Finish:** Architect to select from manufacturer's full and complete lines of finishes. *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

DIVISION 12 - FURNISHINGS

2.55 12 24 13 Roller Shades

- A. **Schedule:**
1. **Motorized:** Provide at all exterior windows in all Classrooms and at Dean's Suite Conference Room. Provide power and circuiting as required for fully operational system.
 2. **Manual Chain Type:** Provide at all other perimeter windows except at west Building Lobby/Atrium, Lobby Atrium 100, vestibules and stairwells. Confirm final locations with Architect.
 3. **Shade Material:** To be selected by Architect from manufacturer's full and complete lines of shading material, perforation patterns and light transmittance percentages.

2.56 12 36 40 Quartz Countertops: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*

- A. Refer to Sections 06 61 16, 12 36 40 and Architect's Finish Selection Summary Spreadsheet.
- B. **Material:** 3cm slab product with 1 ½" exposed edges.
- C. **Edge profile:** Verify with Architect.
- D. **Products:** *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
- E. **Quality:** AWI Custom Grade.
- F. **Finish:** Polished

- 2.57 123643 Stone Countertops: *This section is deleted, (Addendum #10).*
- 2.58 123646 Solid Surfacing Countertops: *Refer to INTERIOR FINISH SPREADSHEET, (Addendum #10).*
- 2.59 12 48 13 Entrance Floor Mats: *This section is deleted, (Addendum #10). Refer to Carpet Tile.*

DIVISION 14 - CONVEYING SYSTEMS

- 2.60 14 21 00 Electric Traction Elevators: *This section is deleted, (Addendum #10).*
- 2.61 14 24 00 Hydraulic Elevators: *(Addendum #10). Refer to section 14 24 00 for manufacturer's standard cab finishes.*
- A. Elevator Cab Floors to be 3/8" Resinous Matrix Terrazzo Flooring to match Architect's sample.

DIVISION 21 - FIRE SUPPRESSION

- 2.62 Division 21
- A. Fire Alarm and Strobe Covers: Bright white

DIVISION 21 - FIRE SUPPRESSION

- 2.63 211000 Water-based Fire-suppression Systems
- A. Valve cabinets: Stainless steel

DIVISION 22 – PLUMBING

- 2.64 224000 Plumbing Fixtures
- A. Porcelain water closets, urinals and wall hung lavatories: White with chrome or stainless steel trim and accessories.
- B. Lavatory bowls: White porcelain with under counter mounting unless noted otherwise.
- C. Break room sinks: Stainless steel under counter mounted unless noted otherwise.
- D. Lab sinks: Stainless steel under counter mounted unless noted otherwise.
- E. EWC's and hydration stations: Stainless steel
- F. Mop sinks: White
- G. Floor drain strainers: Satin nickel

DIVISION 22 - HEATING VENTILATING AND AIR CONDITIONING

- 2.65 233713 Diffusers, Registers, and Grilles
- A. Square mechanical grilles, registers and diffusers in ceilings: Bright white
- B. Slotted mechanical grilles and registers: Clear anodized aluminum.
- C. Eyeball mechanical supply grilles: Bright white or silver, confirm final color with Architect.
- D. Thermostats: Bright White, unless on wood paneling, then match wood paneling

DIVISION 26 - ELECTRICAL

- 2.66 260923 Lighting Control Devices
- A. Bright white nylon Designer series (Leviton Decora or equal) with matching screw heads, typical unless on wood paneling, then match wood paneling.
- B. Stainless steel in mechanical and service areas.

2.67 262726 Wiring Devices

- A. Wall plates including telephone and data plates and other wall mounted controls: Bright white nylon Designer series (Leviton Decora or equal) with matching screw heads except where located in wood paneling at the Learning Stair. At Learning Stair in east Atrium 100, match wood veneer or provide receptacle and cover plate in a color that is visually compatible.
- B. Wall plates in mechanical and service areas: Stainless steel
- C. Floor Devices: To be selected.

2.68 26 51 00 Interior Lighting

- A. Finishes to be selected.

2.69 26 56 00 Exterior lighting

- Finishes to be selected.

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

2.70 283111 Digital, Addressable Fire-alarm System

- A. White alarms and pull stations

2.71 28 23 00 Video Surveillance

- A. Colors to be selected by Architect

DIVISION 32 - EXTERIOR IMPROVEMENTS

2.72 32 17 23 Pavement Markings

- A. **Stall Striping**
 - 1. **Standard parking:** White
 - 2. **Visitors parking:** White
 - 3. **Accessible Parking:** White and Blue
- B. **Curb Painting**
 - 1. **Service Parking:** White curb with blue letters.
 - 2. **Fire Lanes:** Verify with Fire Marshal.
 - 3. **Other:** Confirm with Owner.

2.73 32 17 26 Tactile Warning Surface Tile

- A. Color to be selected.

2.74 Site Brick and Concrete Pavers.

- A. Type and color to be selected. Refer to landscape drawings.

END OF SECTION



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General Notes	Refer to Section 008900 in the specifications for additional infomormation. All painted gypsum board walls to receive Texture: Very Light Orange Peel. Sample to be provided and approved by Architect. All Carpet tile to be installed with Sticky Tabs as per manufacturer. Provide metal trim Schluter Jolly A100ATGB Brushed Nickel Anodized Aluminum at all exposed ceramic tile trim edges/wainscotting. All grout to be SpectraLOCK PRO, color: TBD, to be selected by Architect from full and complete lines of colors All Surface Mounted Wall Protection (WP-1) and End Wall Corner Guards (WP-2) to be #4 brushed stainless steel Hollow metal doors and frames: TBD Sheet Vinyl welded seam cord finish: TBD, to be selected by Architect from full and complete lines of colors Patient Care Equipment w/ laminate insert and/or facing: PL-5 Wilsonart, Color: Biltmore Cherry, Color #: 7924K-07, Texture: Textured Gloss Finish		
LEVEL 1			
100 - Atrium	Terrazzo Flooring	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
Field At curtain wall At Learning Stair	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Paint & Texture	W.PT.EG	TBD Sherwin Williams, Eggshell Finish
	Paint & Texture	W.PT.EG	PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
Alternate	Stain Grade Wood Paneling	W.PNL.WD	ACGI, Product: SS1-1215-C, Species: QTRD SM Cherry, Sample #: 170885-4, Date sent: 08/02/17; Wood paneling to match Architect sample
	Stain Grade Wood Paneling w/ Reveals	W.PNL.WD.01	ACGI, Product: SS1-1215-C, Species: QTRD SM Cherry, Sample #: 170885-4, Date sent: 08/02/17; Wood paneling to match Architect sample; microperforations and acoustical backing as specified
	Storefront Frame & Door	W.GL.AL	Brushed #4 Stainless Steel
	Custom Graphic Vinyl Wallcovering	W.VWC.01	Manufacturer: Trikes, Collection: Digital Wallcovering with Custom Imagery, Digital files of graphic to be provided by Architect
	Prefinished Composite Aluminum Panels	W.CAP	To be selected by Architect from manufacturer's full and complete lines of colors. Refer to 07 42 44
	Structural Tempered Glazing	W.STRG	Refer to 08 80 00 Glazing
	Acoustical Glass Units, 1"	W.GL.AC	GL-4 1/4" Thick Clear, Tempered Glass
	Open Structure Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Structure Above Ceiling		Spray fireproofing, as required, painted black
	Columns and Beams at Curtain Wall		TBD, epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Metal Louvered Wall		PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
101 - Classroom	Carpet Tile	F.CPT.T	CPT-1 Shaw, Collection: Beyond the Fold, Style: Folded Edge Tile 5T062- Custom X078S-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// CPT-4 Shaw, Collection: Beyond the Fold, Style: Folded EW18X36 Tile - Custom # X434Y-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank// Installation Method: Monolithic; Pattern to consist of 40% CPT-4 w/ remaining tiles equally consisting of CPT-1, CPT-2 and CPT-6. Arch to provide final layout
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
101C - Furniture Storage	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"

101E - Display Case	Stain Grade Wood Floor	F.WD	American Cherry, match Architect control sample
	Stain Grade Wood Panel	W.PNL.WD	American Cherry, match Architect control sample
	Tempered Float Glass	W.GL.AL	Brushed #4 Stainless Steel
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
102 - Elevator Equipment Room	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-
103A - Dental Lab/ Classroom	Sheet Vinyl Flooring	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Rubber Base	B.RBR	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Movable Partition	W.MPTN	Panel Finish: Knoll Textiles, Name: Cortland, Style Number: WC1830/3, Color: Mist // Trim & Hinge Paint Finish: to be selected from manufacturer's full and complete lines including premium
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Prefinished painted doors by movable partition manufacturer	R28	Door Finish: Factory prep vinyl to be field painted PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish; Finish to be spray paint applied/ no brushmarks
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
103B - Dental Lab/ Classroom	Sheet Vinyl Flooring	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Movable Partition	W.MPTN	Panel Finish: Knoll Textiles, Name: Cortland, Style Number: WC1830/3, Color: Mist // Trim & Hinge Paint Finish: to be selected from manufacturer's full and complete lines including premium
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Prefinished painted doors by movable partition manufacturer	R28	Door Finish: Factory prep vinyl to be field painted PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish; Finish to be spray paint applied/ no brushmarks
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
103C - Storage	Sheet Vinyl Flooring	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
104 - Data Center	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-
106 - Market	Sealed Concrete	F.SC	-
	No Base	B.NB	-
	Tape & B Gypsum Wall Board Joints	W.T&B	Tape and bed gypsum wallboard joints only (no finish on gyp. board)
	Acoustic Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL

106B - Market Storage		Sealed Concrete Floor	F.SC	–
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-2 Pionite, Color: Azzurra, Color #: AB081-SD, Texture: Textured/Suede // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
110 - Irrigation		Sealed Concrete	F.SC	–
		Rubber Base	B.RBR	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Ceiling, Open to Structure, Unfinished	C.OTS.U	–
120 - Dental Clinic Waiting		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Frame Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
120A - Receptionist		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Millwork	M.SG	American Cherry, match Architect control sample
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
121 - File Room		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
122 - Prog. Sec.		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Frame Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
123 - Clinic Coord.		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
124 - Work/ Copy		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-2 Pionite, Color: Azzurra, Color #: AB081-SD, Texture: Textured/Suede // Horizontal Laminate: Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

125 - Program Chair		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
126 - Faculty		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
127 - Faculty		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
128 - Supervising Dentist		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
129 - Adjunct Faculty		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
131 - Library		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
132 - X-Ray Reading		Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Laminate Millwork	M.PL	Vertical Laminate: PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
132A - X-Ray #1		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
132B - X-Ray #2		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

132C - X-Ray #3	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
132D - X-Ray #4	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
132E - Pan X-Ray	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
140 - Student Lounge	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
140A - Women's Lockers	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Lockers	R27	PL-6 Arborite, Color: Brushed Pewter, Color #: P-325 CA, Finish: Cashmere (CA)
141 - Laundry	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
142 - Oxygen Storage	Waterproof Coated Floor	F.WP	Tremco Commercial Sealants and Waterproofing, Product: Vulkem 350/950NF/950N, Color: Grey
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EP	PT-1 Sherwin Williams, SW9170 Acier, Epoxy paint finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-
143 - Mini Dental Materials	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
144 - Setup Work Room	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Open Cubby Shelves	R37	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

145 - Sterilization	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Open Cubby Shelves	R37	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
146 - Dental Operations	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
Midwest Dental Midwest Dental Midwest Dental	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustic Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Semi-gloss Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
	Solid Surface Top Cap at Half Height Walls	R56	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Casework Countertop		SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Casework Vertical Finish		Integra Dental Casework, Color: Venus Silver
	Dental Chair Upholstery		Ultraleather, Color: Riviera, Part #: 400
1COMM1 - MDF	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Acoustic Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL
1COMP - Dental Compressor and Vacuum	Waterproof Coated Floor	F.WP	Tremco Commercial Sealants and Waterproofing, Product: Vulkem 350/950NF/950N, Color: Grey
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EP	PT-1 Sherwin Williams, SW9170 Acier, Epoxy paint finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-
1CORR1 - Corridor	Terrazzo Floor	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Stain Grade Wood Paneling	W.PNL.WD	American Cherry, match Architect control sample
	Prefinished Composite Aluminum Panels	W.CAP	To be selected by Architect from manufacturer's full and complete lines of colors. Refer to 07 42 44
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
1CORR2 - Corridor	Terrazzo Floor	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Ceiling, Open to Structure, Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
1CORR3 - Corridor	Terrazzo Floor	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Ceramic Wall Tile	W.CT.01	TBD , Size: 12"x24", Finish: Polished, Installation Method: Stacked Bond, Grout Joints: 1/16"
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Ceiling, Open to Structure, Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

1CORR4 - Corridor	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
1CORR5 - Corridor	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
1CORR6 - Corridor	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
1CORR7 - Corridor	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
1CUST1 - Jan./Cust. Storage	Sealed Concrete	F.SC	–
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Fiberglass Reinforced Panels	W.FRP	Marlite, Finish: Pebble Texture, Color: Bright White P-199
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
1ELEC1 - Main Electrical Room	Sealed Concrete	F.SC	–
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	–
1ELEC2 - Elec. Dist.	Sealed Concrete	F.SC	–
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	–
1FIRE1 - Fire Pump Room	Waterproof Coated Floor	F.WP	Tremco Commercial Sealants and Waterproofing, Product: Vulkem 350/950NF/950N, Color: Grey
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EP	PT-1 Sherwin Williams, SW9170 Acier, Epoxy paint finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	–
1LOBB2 - West Lobby	Terrazzo Floor	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent)
	Carpet, Walk Off Tile	F.WT	TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Terrazzo Base, 12"	B.TER.01	WT-1 Miliken, Collection: Quadrus, Pattern: Gravity, Color: Streamline, Color #: GRA118-119, Size: 24" x 24"
	Aluminum Framed Glazing	W.GL.AL	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Digital Graphic Wall Panels	W.PNL.DGWP	Clear Anodized Aluminum Finish
	Paint & Texture	W.PT.EG	Custom digital image sandwiched between (2) sheets of 3/16" acrylic attached to wall with stainless steel standoffs; Architect to provide graphic image file; refer to elevations for panel sizes
	Stain Grade Wood Panel	W.PNL.WD	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	American Cherry, match Architect control sample
			PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture

1MECH1 - Equipment Room	Waterproof Coated Floor	F.WP	Tremco Commercial Sealants and Waterproofing, Product: Vulkem 350/950NF/950N, Color: Grey
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EP	PT-1 Sherwin Williams, SW9170 Acier, Epoxy paint finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-

1MRR1 - Men's Restroom	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Mosaic Tile	W.CT.07	TBD
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish

1MRR2 - Men's Restroom and Locker Room	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish
	Plastic Laminate Lockers	R27	PL-6 Arborite, Color: Brushed Pewter, Color #: P-325 CA, Finish: Cashmere (CA)

1STRW1 - Stair #1	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

1STRW2 - Stair #2	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

1STRW3 - Stair #3	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

1URR1 - Unisex Restroom	Ceramic Tile Floor	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
Single Toilet	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Tile Wall	W.CT.02	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Paint & Texture	W.PT.EG	PT-7 Sherwin Williams, SW9112 Song Thrush, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish

1URR2 - Faculty Unisex RR	Ceramic Tile Floor	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
Single Toilet	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Tile Wall	W.CT.02	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Paint & Texture	W.PT.EG	PT-7 Sherwin Williams, SW9112 Song Thrush, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish

1VEST1 - North Vestibule	Terrazzo Flooring	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Carpet, Walk Off Tile	F.WT	WT-1 Miliken, Collection: Quadrus, Pattern: Gravity, Color: Streamline, Color #: GRA118-119, Size: 24" x 24"
	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Storefront Frame & Door	W.GL.AL	Clear Anodized Aluminum Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
1VEST2 - South Vestibule	Terrazzo Flooring	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Carpet, Walk Off Tile	F.WT	WT-1 Miliken, Collection: Quadrus, Pattern: Gravity, Color: Streamline, Color #: GRA118-119, Size: 24" x 24"
	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Storefront Frame & Door	W.GL.AL	Clear Anodized Aluminum Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
1VEST3 - Vestibule	Terrazzo Flooring	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17
	Carpet, Walk Off Tile	F.WT	WT-1 Miliken, Collection: Quadrus, Pattern: Gravity, Color: Streamline, Color #: GRA118-119, Size: 24" x 24"
	Terrazzo Base, 12"	B.TER.01	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Ceiling, Open to Structure, Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
1WRR1 - Women's Restroom	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Mosaic Tile	W.CT.07	TBD
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-2 Cambria Quartz, Color: Helmsley, Color #:1748, Finish: Polish
1WRR2 - Women's Restroom	Ceramic Tile Floor	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Tile Wall	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-2 Cambria Quartz, Color: Helmsley, Color #:1748, Finish: Polish
E1-L1 - Elev. #1	Terrazzo Flooring	F.TER	(Field) TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17// (Accent) TR-2 to match Architect control sample - Andreola Terrazzo Plate # 2318-17// (Accent) TR-3 to match Architect control sample - Andreola Terrazzo Plate # 2292-17
	Stainless Steel Base	B.SS	Satin Stainless Steel, No. 4 Finish
	Brushed Stainless Steel Panels	W.SS	Satin Stainless Steel, No. 4 Finish
	Brushed Stainless Steel Clg Panel	C.SS	Brushed Stainless Steel
ST-1A - Learning Stair	Terrazzo Flooring	F.TER	TR-1 to match Architect control sample - Andreola Terrazzo Plate # 2266-17
	Wood Riser with Treads	F.WD.R&T	American Cherry, match Architect control sample
	Stain Grade Wood Base, 12"	B.WD.SG.01	American Cherry, match Architect control sample
	Stain Grade Wood Panel	W.PNL.WD	American Cherry, match Architect control sample
	Guardrails, Handrails & Cable Rails	R6	#4 Brushed Stainless Steel
	Stringer		PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
ST-1A2 - Under Learning Stair	Sealed Concrete	F.SC	–
	No Base	B.NB	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Metal Louvered Wall		PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

Level 2			
201 - Nursing Simulation Lab	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201A - Nursing Sim #1	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Aluminum Framed Glazing	W.GL.AL	Brushed #4 Stainless Steel
	Acoustical Glass Units	W.GL.AC	GL-4 1/4" Thick Clear, Tempered Glass
	Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201B - Nursing Sim #2	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Aluminum Framed Glazing	W.GL.AL	Brushed #4 Stainless Steel
	Acoustical Glass Units	W.GL.AC	GL-4 1/4" Thick Clear, Tempered Glass
	Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201C - Nursing Sim #3	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Aluminum Framed Glazing	W.GL.AL	Brushed #4 Stainless Steel
	Acoustical Glass Units	W.GL.AC	GL-4 1/4" Thick Clear, Tempered Glass
	Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201D - Nursing Sim #4	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Aluminum Framed Glazing	W.GL.AL	Brushed #4 Stainless Steel
	Acoustical Glass Units	W.GL.AC	GL-4 1/4" Thick Clear, Tempered Glass
	Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

201E - Nursing Sim #5	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 017 Celeste // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201F - Nursing Sim #6	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 017 Celeste // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201G - Nursing Sim #7	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 017 Celeste // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
201H - Nursing Sim #8	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 017 Celeste // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
202 - Nursing Debriefing Room	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

203 - Lockers	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Lockers	R27	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
204 - Med Room	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
205A - Clean Utility	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
205B - Soiled Utility	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
205C - Scrub Bay	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
206 - Nursing Sim Control Room	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
207 - Simulation Prep Room	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
210A - Sim. Director	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

210B - Sim. Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
210C - Sim. Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
210D - Sim. Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
210E - Sim. Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
210F - Sim Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
211 - Break Room	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
212 - Work/Copy/Mail	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
230 - Radiologic Science Lab	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Plastic Laminate Lockers	R27	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

230A - Lockers	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Lockers	R27	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
231 - X-Ray #5	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Semi-gloss Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
232 - X-Ray #4	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Semi-gloss Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
233 - X-Ray #1	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Semi-gloss Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
234 - X-Ray #2	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Semi-gloss Finish
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

235 - X-Ray #3		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork		M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
		Accent Wall Paint			PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Semi-gloss Finish
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
236 - X-Ray Storage		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
240 - Classroom		Carpet Tile		F.CPT.T	CPT-1 Shaw, Collection: Beyond the Fold, Style: Folded Edge Tile 5T062- Custom X078S-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// CPT-4 Shaw, Collection: Beyond the Fold, Style: Folded EW18X36 Tile - Custom # X434Y-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank// Installation Method: Monolithic; Pattern to consist of 40% CPT-4 w/ remaining tiles equally consisting of CPT-1, CPT-2 and CPT-6. Arch to provide final layout
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint			PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
		Stain Grade Wood Chairrail		R46	WP-4 American Cherry, match Architect control sample
241 - Simulation Equip. Room		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
250 - Respiratory Care Skills Lab		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork		M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
		Solid Surface Countertop		M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint			PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Semi-gloss Finish
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
		Divider Screen Fabric			To be selected by Architect from manufacturer's full and complete list of patterns and colors.
251 - Oxygen		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
252 - Medical Supply Room		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"

253 - Respiratory Care Equipment/ Prep Room		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
255A - R.C. Sim #1		Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
255B - R.C. Sim #2		Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
255C - R.C. Sim #3		Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
255D - R.C. Sim #4		Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
256 - Control Room		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
257 - Lockers		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Lockers	R27	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish

260 - IPE Simulation Room		Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.HP	PT-1 Sherwin Williams, SW9170 Acier, High Performance Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.01	ACT-1 Armstrong World Ind. TECHZONE, 6" Technical Panel, Size: 48" x 48" Optima Acoustical Panel, Color: White Diamond, Edge: Square Tegular, Grid: 9/16" Interlude XL
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, High Performance Eggshell Finish
		Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
261 - Scrub Room		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.HP	PT-1 Sherwin Williams, SW9170 Acier, High Performance Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
261A - IPE Control Room		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
2COMM1 - IDF		Sealed Concrete	F.SC	-
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
		Acoustical Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL
2COMM2 - IDF		Sealed Concrete	F.SC	-
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
		Acoustical Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL
2CORR1 - Corridor		Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Prefinished Composite Aluminum Panels	W.CAP	To be selected by Architect from manufacturer's full and complete lines of colors. Refer to 07 42 44
		Stain Grade Wood Paneling	W.PNL.WD	Quarter Sawn Select American Cherry stained and with clear satin sheen to match Architect's sample; turn grain vertically; Design intent to match wood paneling at Atrium/Lobby 100
		Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
2CORR2 - Corridor		Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
At EWC		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Ceramic Wall Tile	W.CT.01	TBD, Size: 12"x24", Finish: Polished, Installation Method: Stacked Bond, Grout Joints: 1/16"
		Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Ceiling, Open to Structure, Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
		Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

2CORR3 - Corridor	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Rubber Base	B.RBR	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
2CORR4 - Corridor	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
2CORR5 - Corridor	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
2CORR6 - Corridor	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
2CUST1 - Jan. Clo.	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Fiberglass Reinforced Panels	W.FRP	Marlite, Finish: Pebble Texture, Color: Bright White P-199
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-
2ELEC1 - Elec. Dist.	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-
2MRR1 - Men's Restroom	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Mosaic Tile	W.CT.07	TBD
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish
2STRW1 - Stair #1	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
2STRW2 - Stair #2	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

2STRW3 - Stair #3	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
2STRW4 - Main Stair	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Metal Ceiling Panels	C.MPNL	PT-6 Sherwin Williams, SW7046 Anonymous; Low sheen satin finish
	Guardrails, Handrails & Cable Rails	R6	#4 Brushed Stainless Steel
	Stringer	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
2WRR1 - Women's Restroom	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Mosaic Tile	W.CT.07	TBD
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-2 Cambria Quartz, Color: Helmsley, Color #:1748, Finish: Polish
Level 3			
301 - Student Collaboration	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
	Guardrail, Cable rail and Top rail		#4 Brushed Stainless Steel
302 - Classroom	Carpet Tile	F.CPT.T	CPT-1 Shaw, Collection: Beyond the Fold, Style: Folded Edge Tile 5T062- Custom X078S-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// CPT-4 Shaw, Collection: Beyond the Fold, Style: Folded EW18X36 Tile - Custom # X434Y-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank// Installation Method: Monolithic; Pattern to consist of 40% CPT-4 w/ remaining tiles equally consisting of CPT-1, CPT-2 and CPT-6. Arch to provide final layout
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Brushed #4 Stainless Steel
	Acoustical Glass Units, 1"	W.GL.AC	GL-4 1/4" Thick Clear, Tempered Glass
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	American Cherry, match Architect control sample
303 - Anatomage/ Virtual Lab	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Stain Grade Wood Chairrail	R46	American Cherry, match Architect control sample

303A - Storage		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
304 - Classroom		Carpet Tile	F.CPT.T	CPT-1 Shaw, Collection: Beyond the Fold, Style: Folded Edge Tile 5T062- Custom X078S-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// CPT-4 Shaw, Collection: Beyond the Fold, Style: Folded EW18X36 Tile - Custom # X434Y-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank// Installation Method: Monolithic; Pattern to consist of 40% CPT-4 w/ remaining tiles equally consisting of CPT-1, CPT-2 and CPT-6. Arch to provide final layout
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
		Stain Grade Wood Chairrail		American Cherry, match Architect control sample
305 - Clinic		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
306 - Clinic		Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
307 - Break Room		Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	PL-2 Pionite, Color: Azzurra, Color #: AB081-SD, Texture: Textured/Suede
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
310 - Classroom		Carpet Tile	F.CPT.T	CPT-1 Shaw, Collection: Beyond the Fold, Style: Folded Edge Tile 5T062- Custom X078S-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// CPT-4 Shaw, Collection: Beyond the Fold, Style: Folded EW18X36 Tile - Custom # X434Y-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank// Installation Method: Monolithic; Pattern to consist of 40% CPT-4 w/ remaining tiles equally consisting of CPT-1, CPT-2 and CPT-6. Arch to provide final layout
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
		Stain Grade Wood Chairrail	R46	American Cherry, match Architect control sample
330 - Advising		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Stain Grade Wood Chairrail		WP-4 American Cherry, match Architect control sample

330A - Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
330B - Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
330C - Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
331 - Work/Copy	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-2 Pionite, Color: Azzurra, Color #: AB081-SD, Texture: Textured/Suede // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
332 - Storage	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
334B - Lockers	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Lockers	R27	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
340 - Classroom	Carpet Tile	F.CPT.T	CPT-1 Shaw, Collection: Beyond the Fold, Style: Folded Edge Tile 5T062- Custom X078S-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// CPT-4 Shaw, Collection: Beyond the Fold, Style: Folded EW18X36 Tile - Custom # X434Y-0, Color: Sundried Ecru, Size: 18 x 36" Plank// CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank// Installation Method: Monolithic; Pattern to consist of 40% CPT-4 w/ remaining tiles equally consisting of CPT-1, CPT-2 and CPT-6. Arch to provide final layout
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
350 - Nursing Skills Lab #1	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

350A - Skills Bed #1		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Gypsum Wallboard Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Hospital Curtain		R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
350B - Skills Bed #2		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Gypsum Wallboard Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Hospital Curtain		R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
350C - Skills Bed #3		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Gypsum Wallboard Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Hospital Curtain		R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
350D - Skills Bed #4		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Gypsum Wallboard Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Hospital Curtain		R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

350E - Skills Bed #5	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

350F - Skills Bed #6	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

350G - Skills Bed #7	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

350H - Skills Bed #8	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

351 - Nursing Equipment Storage	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

352 - Debriefing Room		Carpet Tile		F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
353 - Controls		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork		M.PL	Vertical Laminate: PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
354 - Dirty/Clean Room		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
355 - Med Room		Sheet Vinyl Floor		F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.SG	PT-1 Sherwin Williams, SW9170 Acier, Semi-gloss Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork		M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
		Solid Surface Countertop		M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360 - Nursing Skills Lab #2		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
Upper cabinets		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Writable Wall Surface Paint		W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork		M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360A - Skills Bed #16		Sheet Vinyl Floor		F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
		Sheet Vinyl Base		B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Gypsum Wallboard Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
		Hospital Curtain		R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
		Vinyl Chairrail		R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

360B - Skills Bed #15	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360C - Skills Bed #14	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360D - Skills Bed #13	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360E - Skills Bed #12	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360F - Skills Bed #11	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119

360G - Skills Bed #10	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
360H - Skills Bed #9	Sheet Vinyl Floor	F.SV	(Field) RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146// (Accent) RS-2 Forbo, Marmoleum, Real Series, Color: Lava 3139// (Accent) RS-3 Forbo, Marmoleum, Real Series, Color: Fresco Blue 3055// (Accent) RS-4 Forbo, Marmoleum, Real Series, Color: Dove Blue 3053; reference drawings for locations
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Writable Wall Surface Paint	W.WS	Installed over two coats of flat latex and primer coat per manufacturer's recommendation, Color: PT-1 Sherwin Williams, SW9170 Acier, Min. Level 4 finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish
	Hospital Curtain	R39	Cubicle track: Inpro, Clickeze Optitrac, Cubicle Track, Color: White// Curtain: Maharam, Pattern: Tabby 511488, Color: 019 Grotto // Mesh color: to be selected from manufacturer's full and complete line of colors; Open mesh top 24" and 8" gap at floor, Curtains to completely enclose bed at all sides
Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119	
361 - Lockers	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Plastic Laminate Lockers	R27	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
362 - Storage	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
363 - Home Health	Sheet Vinyl Floor	F.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Sheet Vinyl Base	B.SV	RS-1 Forbo, Marmoleum, Real Series, Color: Serene Grey 3146
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-1 Arborite, Color: Tatami Denimu, Color #: P-310 CA, Texture: Cashmere
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Vinyl Chairrail	R45	WP-3 Inpro, Color: Pepperdust, Color #: 0119
3COMM1 - IDF	Sealed Concrete	F.SC	–
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Acoustical Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL
3CORR1 - Corridor	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Prefinished Composite Aluminum Panels	W.CAP	To be selected by Architect from manufacturer’s full and complete lines of colors. Refer to 07 42 44
	Stain Grade Wood Paneling	W.PNL.WD	Quarter Sawn Select American Cherry stained and with clear satin sheen to match Architect’s sample; turn grain vertically; Design intent to match wood paneling at Atrium/Lobby 100
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail	R45	WP-4 American Cherry, match Architect control sample
Painted Hardware Cloth at Smoke Evac.	R50	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings	

3CORR2 - Corridor	Luxury Vinyl Tile	F.LVT	LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

3CORR3 - Corridor	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Ceramic Wall Tile	W.CT.01	TBD, Size: 12"x24", Finish: Polished, Installation Method: Stacked Bond, Grout Joints: 1/16"
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Ceiling, Open to Structure, Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

3CORR4 - Corridor	Luxury Vinyl Tile	F.LVT	LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

3CUST1 - Janitor/ Storage	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Fiberglass Reinforced Panels	W.FRP	Marlite, Finish: Pebble Texture, Color: Bright White P-199
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-

3ELEC1 - Electrical Dist.	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamourous White, Semi-gloss finish
	Ceiling, Open to Structure, Unfinished	C.OTS.U	-

3MRR1 - Men's Restroom	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Mosaic Tile	W.CT.07	TBD
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish

3STRW1 - Stair #1	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

3STRW2 - Stair #2	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

3STRW3 - Stair #3	Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
	Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
	Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

3STRW4 - Main Stair	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Metal Ceiling Panels	C.MPNL	PT-6 Sherwin Williams, SW7046 Anonymous; Low sheen satin finish
	Guardrails, Handrails & Cable Rails	R6	#4 Brushed Stainless Steel
	Stringer	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

3WRR1 - Women's Restroom	Ceramic Floor Tile	F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
	Ceramic Tile Base	B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
	Ceramic Wall Tile	W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #:
	Mosaic Tile	W.CT.07	TBD
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Quartz Countertop	M.QTZ	QTZ-2 Cambria Quartz, Color: Helmsley, Color #:1748, Finish: Polish

Level 4

401 - Faculty Collaboration	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

410 - Dean's Reception	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
12" LVT border (R52)	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Stain Grade Wood Base	B.WD.SG.02	American Cherry, 4", match Architect control sample
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

411 - Dean's Waiting	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
12" LVT border (R52)	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Stain Grade Wood Base	B.WD.SG.02	American Cherry, 4", match Architect control sample
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

412 - Dean's Conference Room	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
12" LVT border (R52)	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Stain Grade Wood Base	B.WD.SG.02	American Cherry, 4", match Architect control sample
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Fabric Wrapped Panels	W.AFWP	AFWP-1 Manufacturer: Knoll Textiles, Pattern: Bandwidth, Color: Static, Color #: W1219/1
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
413 - Admin.	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
12" LVT border (R52)	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Stain Grade Wood Base	B.WD.SG.02	American Cherry, 4", match Architect control sample
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
414 - Break Room	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
415 - Dean's Office	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Stain Grade Wood Base	B.WD.SG.02	American Cherry, 4", match Architect control sample
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
416 - Work Copy	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
418 - Recruitmemt Storage	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
420 - RC Reception	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

420A - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420B - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420C - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420D - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420E - RC Chair		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
420F - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420G - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420H - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
420J - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

421 - Work/Copy		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
422 - Co Arc		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
423 - Circulation		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
424 - Break Room		Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
425 - Circulation		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
426 - Circulation		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
430 - Reception/ Waiting		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
430A - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

430B - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430C - Work/Copy		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430D - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430E - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430F - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430G - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430H - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430J - Secretary		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430K - Chair's Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

430L - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430M - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430N - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430P - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430Q - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430R - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430S - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
430T - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
431 - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
432 - Files		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"

433 - Break Room	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
434 - Storage	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
435 - Storage	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
436A - Circulation	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
436B - Storage	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
436C - Circulation	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
436D - Circulation	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
436E - Circulation	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

440 - Reception/ Waiting		Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Millwork	M.SG	American Cherry, match Architect control sample
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
440AA - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440AB - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440AC - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440A - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440B - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440C - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440D - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440E - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

440F - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440G - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440H - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440J - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440K - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440L - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440M - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440N - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440P - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440Q - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

440R - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440S - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440T - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440U - Storage		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
440V - Chair's Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
440W - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440X - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440Y - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
440Z - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
441 - Student Workers		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"

442 - Nursing Collaboration	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
443 - Breakroom	Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
	Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
444 - Workstations	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
445 - Workstations	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
446 - Conference	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
447 - Work/ Copy	Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
	Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
448A - Circulation	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample

448B - Circulation		Carpet Tile		F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Wood Chairrail		R46	WP-4 American Cherry, match Architect control sample
448C - Circulation		Carpet Tile		F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Wood Chairrail		R46	WP-4 American Cherry, match Architect control sample
448D - Circulation		Carpet Tile		F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stain Grade Wood Chairrail		R46	WP-4 American Cherry, match Architect control sample
448 - Files		Carpet Tile		F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
450 - SW Reception		Carpet Tile		F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; Install accent carpet tile at random up to 20% of total carpet tiles used in room. Provide shop drawings that show locations of accent carpet tiles for final approval
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing		W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint			PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail		R46	WP-4 American Cherry, match Architect control sample
450A - Office		Carpet Tile		F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint			PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
450B - Office		Carpet Tile		F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint			PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
450C - Office		Carpet Tile		F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint			PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish

450D - SW Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
		Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
450E - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
450F - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
451 - Break Room		Luxury Vinyl Tile	F.LVT	LVT-1 CBC Flooring, Manufacturer: Toli, Collection: Lightwood, Color: Dark Cherrywood, Color #: 7283E, Size: 6" x 36", 3mm, Wearlayer: .5mm (.020")
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Plastic Laminate Millwork	M.PL	PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish
		Solid Surface Countertop	M.SOLS	SS-1 Wilsonart, Solid Surface, Color: Morning Ice, Color #: 9204CE, Finish: Gloss
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
452 - Work/ Copy		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Plastic Laminate Millwork	M.PL	Vertical Laminate: PL-3 Formica, Color: Fossil, Color #: 5349-PX, Texture: Plex Finish // Horizontal Laminate: PL-4 Wilsonart, Color: Pearl Soapstone, Color #: 4886-38, Texture: Fine Velvet
453 - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
454 - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
455 - Office		Carpet Tile	F.CPT.T	CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank; Installation Method: Brick
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Accent Wall Paint		PT-5 Sherwin Williams, SW2811 Rockwood Blue Green, Eggshell Finish
4COMM1 - IDF		Sealed Concrete	F.SC	-
		Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture	W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamorous White, Semi-gloss finish
		Acoustical Ceiling Tile	C.ACT.03	ACT-3 Armstrong World Ind. Cortega #770, Size: 24" x 24", Color: White Diamond, Edge: Square Lay-in, Grid: 15/16" Prelude XL

4CORR1 - Corridor	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Prefinished Composite Aluminum Panels	W.CAP	To be selected by Architect from manufacturer's full and complete lines of colors. Refer to 07 42 44
	Stain Grade Wood Paneling	W.PNL.WD	Quarter Sawn Select American Cherry stained and with clear satin sheen to match Architect's sample; turn grain vertically; Design intent to match wood paneling at Atrium/Lobby 100
	Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
	Gypsum Wall Board Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
	Painted Hardware Cloth at Smoke Evac.	R50	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
4CORR2 - Corridor	Luxury Vinyl Tile	F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Ceramic Wall Tile	W.CT.01	TBD, Size: 12"x24", Finish: Polished, Installation Method: Stacked Bond, Grout Joints: 1/16"
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Ceiling, Open to Structure, Painted	C.OTS.PT	Ceiling open to structure to be painted flat black
	Accent Wall Paint		PT-4 Sherwin Williams, SW2802 Rockwood Red, Eggshell Finish
	Stain Grade Wood Chairrail	R46	WP-4 American Cherry, match Architect control sample
4CORR3 - Corridor	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; refer to plans for pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail		WP-4 American Cherry, match Architect control sample
4CORR4 - Corridor	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; refer to plans for pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail		WP-4 American Cherry, match Architect control sample
4CORR5 - Corridor	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; refer to plans for pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
	Stain Grade Wood Chairrail		WP-4 American Cherry, match Architect control sample
4CORR6 - Corridor	Carpet Tile	F.CPT.T	(Field) CPT-2 Shaw, Collection: Beyond the Fold, Style: Expand Tile 5T059, Color: Ecru, Color #: 59105, Size: 18 x 36" Plank// (Accent) CPT-6 Shaw, Collection: Beyond the Fold, Style: Folded Tile 18X36- Custom # X436Y-0, Color: Shimmer Ecru, Size: 18 x 36" Plank; refer to plans for pattern
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
	Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
	Stain Grade Wood Chairrail		WP-4 American Cherry, match Architect control sample
4CUST1 - Janitor/ Storage	Sealed Concrete	F.SC	-
	Rubber Base	B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
	Fiberglass Reinforced Panels	W.FRP	Marlite, Finish: Pebble Texture, Color: Bright White P-199
	Gypsum Wallboard Ceiling	C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture

4ELEC1 - Electrical Dist.		Sealed Concrete		F.SC	-
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.SG	PT-2 Sherwin Williams, SW1901 Glamorous White, Semi-gloss finish
		Ceiling, Open to Structure, Unfinished		C.OTS.U	-

4MRR1 - Men's Restroom		Ceramic Floor Tile		F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
		Ceramic Tile Base		B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
		Ceramic Wall Tile		W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
		Mosaic Tile		W.CT.07	TBD
		Gypsum Wall Board Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Quartz Countertop		M.QTZ	QTZ-1 Cambria Quartz, Color: Hollinsbrook, Color #:5221, Finish: Polish

4STRW1 - Stair #1		Rubber Floor		F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
		Rubber Base		B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing		W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stringers		R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Handrails, Balusters & Guardrails		R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

4STRW2 - Stair #2		Rubber Floor		F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
		Rubber Base		B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing		W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile		C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stringers		R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Handrails, Balusters & Guardrails		R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Accent Wall Paint			PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

4STRW3 - Stair #3		Rubber Floor		F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
		Rubber Base		B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing		W.GL.AL	Clear Anodized Aluminum Finish
		Stringers		R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Handrails, Balusters & Guardrails		R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

3STRW4 - Main Stair		Luxury Vinyl Tile		F.LVT	(Field) LVT-2 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Chalk 16515, Size: 18" x 36", Wearlayer: 20 mil// (Accent) LVT-3 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Pebble 16530, Size: 18" x 36", Wearlayer: 20 mil// LVT-4 Shaw Contract, Style Name: Strand, Style #: 0516V, Color: Silt 16595, Size: 18" x 36", Wearlayer: 20 mil; reference drawings for floor pattern
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Metal Ceiling Panels		C.MPNL	PT-6 Sherwin Williams, SW7046 Anonymous; Low sheen satin finish
		Guardrails, Handrails & Cable Rails		R6	#4 Brushed Stainless Steel
		Stringer		R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings

4WRR1 - Women's Restroom		Ceramic Floor Tile		F.CT.06	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Unpolished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
		Ceramic Tile Base		B.CT.01	CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, 12" x 24" cut to 3"
		Ceramic Wall Tile		W.CT.04	(Field) CT-1 Daltile, Ironcraft Series, Color: Casper Grey, Color #: IC12, Finish: Lightly Polished, Size: 12" x 24"// (Accent) CT-3 Daltile, Ironcraft Series, Color: Rusted Bronze, Color #: IC14, Finish: Lightly Polished, Size: 12" x 24" cut to 3"; refer to drawings for installation pattern
		Mosaic Tile		W.CT.07	TBD
		Gypsum Wall Board Ceiling		C.GWB.PT	PT-2 To match Sherwin Williams SW 1901 Glamorous White, flat latex, no texture
		Quartz Countertop		M.QTZ	QTZ-2 Cambria Quartz, Color: Helmsley, Color #:1748, Finish: Polish

Level 5

SMECH1 - Mechanical Penthouse		Waterproof Coated Floor		F.WP	Tremco Commercial Sealants and Waterproofing, Product: Vulkem 350/950NF/950N, Color: Grey
		Rubber Base		B.RBR	RB-1 Roppe, 4" cove base, Color: Dolphin 129
		Paint & Texture		W.PT.EP	PT-1 Sherwin Williams, SW9170 Acier, Epoxy paint finish
		Ceiling, Open to Structure, Unfinished		C.OTS.U	-

5STRW2 - Stair #2		Rubber Floor	F.RBR	RF-1 Nora System, Type: Norament round 0882, Color: Platinum Grey
		Rubber Base	B.RBR	RB-2 Roppe, 4" Rubber Base, Color: Lunar Dust 114
		Paint & Texture	W.PT.EG	PT-1 Sherwin Williams, SW9170 Acier, Eggshell Finish
		Aluminum Framed Glazing	W.GL.AL	Clear Anodized Aluminum Finish
		Acoustical Ceiling Tile	C.ACT.02	ACT-2 Armstrong World Ind. Dune # 1775, Color: White Diamond, Edge: Beveled Tegular, Grid: Suprafine 9/16"
		Stringers	R8	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Handrails, Balusters & Guardrails	R19	PT-6 Sherwin Williams, SW7046 Anonymous; epoxy semi-gloss finish, reference 09 97 13 steel coatings
		Accent Wall Paint		PT-3 Sherwin Williams, SW7607 Santorini Blue, Eggshell Finish

SECTION 011000

SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section Includes:

1. **Project information.**
2. **Work covered by Contract Documents.**
3. **Phased construction.**
4. **Work by Owner.**
5. **Work under separate contracts.**
6. **Access to site.**
7. **Coordination with occupants.**
8. **Work restrictions.**

1.3 PROJECT INFORMATION

- A. **Project Description:** The Project is known as Midwestern State University Health Science and Human Services Center (HSHSC) Building. It is an 88,000 GSF 4 story concrete framed building consisting of brick veneer, terra cotta rain screen, cast stone, composite aluminum panels, ribbed metal panels, plaster soffits, insulated glazed curtain wall, storefront entrances, sitework, modified bitumen roofing, Spanish tile roofing, penthouses and equipment, medical gases, various interior finishes, elevators, smoke evacuation systems, audio visual equipment, mechanical equipment, electrical systems, IT equipment and cabling, structural concrete, and other types of construction.
- B. **Owner:**
 1. **Owner's Designated Representative:** Kyle Owen, Associate Vice President for Facilities Services, 3410 Taft Blvd., Wichita Falls, TX 76308; ph. 940.397.4648.
- C. **Architect:** Randall Scott Architects, Inc., ph. 972.664.9100, address: 2140 Lake Park Blvd., Suite 300, Richardson, TX 75080.
 1. **Architect's Designated Representative:** Vance Lazar, AIA - Vice President, ph. 972.664.9100, address: 2401 Lake Park Blvd., Suite 300, Richardson, TX 75080.
- D. **Construction Manager at Risk:**
 1. Construction Manager at Risk for this Project is Sundt Construction, 2421 W. 7th Street, Suite 300, Ft. Worth, TX 76107, ph., 817.349.2910; Project Manager is Bob Aniol, ph. 210.328.9661; and is also the Project's constructor. In Division 01 through 49 Sections, the terms "Construction Manager" and "Contractor" are synonymous.
- E. **Project Web Site:** A Project Management Web Site (Newforma) administered by the Architect will be used for purposes of managing communication and documents during this project.
 1. See Section 013100 "Project Management and Coordination." for Construction Manager's requirements for utilizing the Project Web Site.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
- B. **Type of Contract:**
 1. Project will be constructed under a **Construction Manager at Risk** contract.

1.5 PHASED CONSTRUCTION

- A. Before commencing Work, submit an updated copy of Construction Manager's construction schedule showing the sequence, commencement and completion dates, and move-in dates of Owner's personnel for the Work.

1.6 WORK BY OWNER

- A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. **Subsequent Work:** Owner will perform the following additional work at site while work on this project is underway. Completion of that work will depend on successful coordination and preparatory work under this Contract.
 - 1. Relocation of certain equipment from the existing Bridwell Building to the new HSHSC Building.

1.7 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. **Preceding Work:** Owner will award separate contract(s) for the following construction operations at Project site. Those operations are scheduled to be ongoing during the course of this Contract.
 - 1. Redevelopment of the quad area to the east of the HSHSC Building.

1.8 ACCESS TO SITE

- A. General: Construction Manager shall have full use of Project site for construction operations during construction period. Construction Manager's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. No existing building will remain or limit the Construction Manager's use of the site.

1.9 COORDINATION WITH OCCUPANTS

- A. **Owner Limited Occupancy of Completed Areas of Construction:** Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 - 1. Architect will prepare a punch list and a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 - 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 - 3. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 - 4. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.10 WORK RESTRICTIONS

- A. **Work Restrictions, General:** Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. **Existing Utility Interruptions:** Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 - 1. **Notify Owner not less than two days in advance of proposed utility interruptions.**

2. Obtain Owner's written permission before proceeding with utility interruptions.
- C. **Noise, Vibration, and Odors:** Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 1. **Notify Owner not less than two days in advance of proposed disruptive operations.**
 2. Obtain Owner's written permission before proceeding with disruptive operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 012100

ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements governing allowances.**
 - 1. **Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Construction Manager. If necessary, additional requirements will be issued by Change Order.**
- B. **Types of allowances include the following:**
 - 1. **Lump-sum allowances.**
 - 2. **Unit-cost allowances.**
 - 3. **Quantity allowances.**
 - 4. **Contingency allowances.**
 - 5. **Testing and inspecting allowances.**

1.3 SELECTION AND PURCHASE

- A. **At the earliest practical date after award of the Contract, advise Architect of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.**
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

1.4 SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified for Change Orders.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- D. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 LUMP-SUM, UNIT-COST, AND QUANTITY ALLOWANCES

- A. **Allowance shall include cost to Construction Manager of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to Project site.**
- B. Unless otherwise indicated, Construction Manager's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials (selected by Architect under allowance) shall be included as part of the Contract Sum and not part of the allowance.
- C. **Unused Materials:** Return unused materials purchased under an allowance to manufacturer or

supplier for credit to Owner, after installation has been completed and accepted.

1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.7 CONTINGENCY ALLOWANCES

- A. Change Orders authorizing use of funds from the contingency allowance will include Construction Manager's related costs and reasonable overhead and profit margins.
- B. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.8 TESTING AND INSPECTING ALLOWANCES

- A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
- B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
- C. Costs of services not required by the Contract Documents are not included in the allowance.
- D. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to Owner by Change Order.

1.9 ADJUSTMENT OF ALLOWANCES

- A. **Allowance Adjustment: To adjust allowance amounts, Architect will prepare a Change Order proposal based on the difference between purchase amount and the allowance,** multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.
 4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.
 2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

- A. ~~Allowance No. 1: Exterior Building Mockup - \$30,000.~~
- B. Allowance No. 1: Exterior Building Mockup - \$30,000.
- C. ~~Allowance No. 2: Interior Open Wall Photographic Documentation - \$2,500.~~
- D. ~~Allowance No. 3: Window Testing - \$40,000.~~
- E. Allowances No. 4 through 11: \$13,100.00:
 - 1. **Allowance No. 4:** Liebert CRAC Units: (5) Unity Communications Cards with Programming/ Graphics tied into Andover BACnet MSTP - \$6,000.00.
 - 2. **Allowance No. 5:** Fulton Condensing Boilers: (1) Gateway Communications (serves multiple boilers) Card with Programming/ Graphics tied into Andover BACnet MSTP - \$3,500.00.
 - 3. **Allowance No. 6:** Mitsubishi Split System:
 - 4. **Allowance No. 7:** Marlowe Domestic Water Softeners:
 - 5. **Allowance No. 8:** Syncroflo Domestic Water Packaged Booster Pump: (1) BACnet MS/TP serial interface card with on-site programming from startup tech.
 - 6. **Allowance No. 9:** Beacon Medeas Medical Vacuum Pump: (1) BACnet option: \$1,200.00.
 - 7. **Allowance No. 10:** Beacon Medeas Instrument Air Comprssor: (1) BACnet option: \$1,200.00.
 - 8. **Allowance No. 11:** Beacon Medeas Med Gas Alarm: (1) BACnet option: \$1,200.00.

END OF SECTION

SECTION 012200

UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for unit prices.**

1.3 DEFINITIONS

- A. **Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.**

1.4 PROCEDURES

- A. **Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.**
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Construction Manager's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Construction Manager.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. **Unit Price No. 1:** 18" Auger Cast Piles Add per foot of length \$_____ per lineal foot; Deduct per foot of length \$_____ per lineal foot.
- B. **Unit Price No. 2:** 30" Auger Cast Piles Add per foot of length \$_____ per lineal foot; Deduct per foot of length \$_____ per lineal foot.
- C. **Unit Price No. 3:** 36" Auger Cast Piles Add per foot of length \$_____ per lineal foot; Deduct per foot of length \$_____ per lineal foot.
- D. **Unit Price No. 4:** 48" Auger Cast Piles Add per foot of length \$_____ per lineal foot; Deduct per foot of length \$_____ per lineal foot.

END OF SECTION

SECTION 012300

ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for alternates.**

1.3 DEFINITIONS

- A. **Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.**
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. **Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.**
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. **Alternate No. 1 – ~~Terra Cotta~~: Not Used**
 - 1. ~~Base Bid: Provide 18 mil thickness terra cotta exterior cladding.~~
 - 2. ~~Alternate Bid: Provide 30 mil thickness terra cotta in lieu of base bid thickness.~~
- B. **Alternate No. 2 – ~~Parking and paving~~: Not Used**
 - 1. ~~Base Bid: Provide north parking lot drive/fire lane and parking spaces only on the south side of the drive.~~
 - 2. ~~Alternate Bid: In addition to base bid paving, add parking spaces on the north side of the drive.~~

- C. **Alternate No. 3 – Stair tower roofs: Not Used**
1. ~~**Base Bid:** Provide flat roofs on 3 stair towers with Mod. Bit. roofing. Include two scuppers per stair tower to drain to main roof.~~
 2. ~~**Alternate Bid:** Provide Spanish tile roofs at all 3 stair towers.~~
- D. **Alternate No. 4 - Hospital Headwalls:**
1. **Base Bid:** Provide all devices shown to be mounted in headwalls to be directly mounted in the drywall partitions in lieu of manufactured headwalls at bed stations in 201E, 201F, 201G, 201H, 255A, 255B, 350A, 350B, 350C, 350D, 350E, 350F, 350G, 350H, 360F, 360G, and 360H. Bed stations with windows onto the atrium at 201A, 201B, 201C, 201D, 255C, 255D, 260, 360A, 360B, 360C, 360D, and 360E will be furnished as manufactured headwalls as part of base bid.
 2. **Alternate Bid:** In addition to the manufactured base bid headwalls, provide manufactured headwall units at all locations in lieu of the simulated headwalls provided in base bid.
- E. **Alternate No. 5 – ITV Classroom Equipment:**
1. **Base Bid:** Delete all ITV equipment. Provide infrastructure as required for future equipment.
 2. **Alternate Bid:** Provide all ITV Equipment in addition to infrastructure.
- F. **Alternate No. 6: Not Used.**
- G. **Alternate No. 7 – Internal office suite partitions heights at all interior offices: Not Used**
1. ~~**Base Bid:** Construct all internal partitions within office suites to deck with acoustic insulation to full height of all walls. Acoustic insulation is not required at ceilings.~~
 2. ~~**Alternate Bid:** Where indicated in the drawings by partition type designations revise internal partitions to be constructed to 6" above finish ceiling. At such locations provide acoustic batts to top of such partitions. Provide batt insulation to minimum of 4 feet either side of partitions that do not go to deck.~~
- H. **Alternate No. 8: Not Used.**
- I. **Alternate No. 9: Not Used.**
- J. **Alternate No. 10 – Brick specification:**
1. **Base Bid:** Use campus standard Cloud Brick as specified.
 2. **Alternate:** Use Acme Brick in lieu of campus standard brick.
- K. **Alternate No. 11 – Countertops: Not Used**
1. ~~**Base Bid:** Provide quartz countertops at all locations. Public restroom lavatory tops are stone.~~
 2. ~~**Alternate Bid:** Provide plastic laminate countertops at all locations in lieu of quartz. Public restroom lavatory tops remain as stone.~~
- L. **Alternate No. 12 – Copings: Not Used**
1. ~~**Base Bid:** Cast stone copings to be provided as indicated on current drawings.~~
 2. ~~**Alternate Bid:** Metal copings to be provided where current drawings indicate cast stone copings.~~
- M. **Alternate No. 13 – Shell in Social Work office suite: Not Used**
1. ~~**Base Bid:** Provide the complete finish out of the Social Work office suite as indicated on the drawings.~~
 2. ~~**Alternate Bid:** The Social Work office suite to be constructed as shell space. Interior partitions, finishes, ceiling, lighting, and infrastructure are not provided. Note: This assumes that Social Work would remain in its current location until such time as the Social Work office finish out can be completed. Provide minimal lighting, egress door and mechanical trunk lines to space as part of shell construction.~~
- N. **Alternate No. 14 – Shell in the Advising office suite: Not Used**

1. ~~**Base Bid:** Provide the complete finish out of the Advising office suite as indicated on the drawings.~~
2. ~~**Alternate Bid:** The Advising office suite to be constructed as shell space. Interior partitions, finishes, ceiling, lighting, and infrastructure are not provided. Note: This assumes that Advising would remain in its current location until such time as the Advising office finish out can be completed. Provide minimal lighting, egress door and mechanical trunk lines to space as part of shell construction.~~
- O. **Alternate No. 15 – Shell in the third floor Breakroom: Not Used**
 1. ~~**Base Bid:** Provide the complete finish out of the 3rd floor Breakroom as indicated on the drawings.~~
 2. ~~**Alternate Bid:** The 3rd floor Breakroom to be constructed as shell space. Interior partitions, finishes, ceiling, lighting, and infrastructure are not provided. Note: This assumes that the Breakroom would be finished out when funds are available. Provide minimal lighting, egress door and mechanical trunk lines to space as part of shell construction.~~
- P. **Alternate No. 16 – Shell in the Dental Hygiene suite: Not Used**
 1. ~~**Base Bid:** Provide the complete finish out of the Dental Hygiene Department as indicated on the drawings.~~
 2. ~~**Alternate Bid:** The Dental Hygiene Suite is to be constructed as shell space. Interior partitions, finishes, ceiling, lighting, and infrastructure are not provided. Note: This assumes that Dental Hygiene would remain in its current location until such time as the Dental Hygiene suite finish out can be completed. Provide minimal lighting, egress door and mechanical trunk lines to space as part of shell construction.~~
- Q. **Alternate No. 17 – Shell in 1/3 of the office space on the 4th floor: Not Used**
 1. ~~**Base Bid:** Provide the complete finish out of all 4th floor office areas as indicated on the drawings.~~
 2. ~~**Alternate Bid:** Identify 1/3 of the 4th floor office spaces to remain as shell space. Note: This assumes that the 4th floor shell spaces would be finished out when funds are available. Provide minimal lighting, egress doors and mechanical trunk lines to spaces as part of shell construction.~~
- R. **Alternate No. 18 – Floor finishes in public corridors: Not Used**
 1. ~~**Base Bid:** Provide terrazzo flooring at public circulation area on 1st, 2nd, 3rd, and 4th floors. Substitute LVT flooring in lieu of terrazzo at 2nd, 3rd, and 4th floors.~~
 2. ~~**Alternate Bid:** Provide terrazzo flooring at public circulation areas on on 1st, 2nd, 3rd, and 4th floors. Floor patterns are to remain as indicated on drawings regardless of whether base bid or alternate floor material is used.~~
- S. **Alternate No. 19 - Digital Graphic Wall Covering:**
 1. **Base Bid:** As indicated on the drawings.
 2. **Alternate Bid:** Provide Digital Graphic Wall Covering as described in Section 008900, 097200 - Wall Covering.
- T. **Alternate No. 20: Digital Graphic Wall Panels:**
 1. **Base Bid:** As indicated on the drawings.
 2. **Alternate Bid:** Provide Digital Graphic Wall Panels as described in Section 008900, 097763 - Digital Graphic Wall Panels.
- U. **Alternate No. 21 - Sand-Oil Separator at Hydraulic Elevators:**
 1. **Base Bid:** As indicated on the drawings and in Section 142400 - Hydraulic Elevators.
 2. **Alternate Bid:** Provide sand-oil separator at each hydraulic elevator.

END OF SECTION

SECTION 012500

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for substitutions.**

1.3 DEFINITIONS

- A. **Substitutions:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Construction Manager.
 - 1. **Substitutions for Cause:** Changes proposed by Construction Manager that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. **Substitutions for Convenience:** Changes proposed by Construction Manager or Owner that are not required in order to meet other Project requirements but may offer advantage to the Owner.

1.4 SUBMITTALS

- A. **Substitution Requests:** Submit one PDF file of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. **Substitution Request Form: Use form at end of this Section.**
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. **Statement** indicating why specified product, fabrication, or installation cannot be provided, if applicable.
 - b. **Coordination information**, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will be necessary to accommodate proposed substitution.
 - c. **Detailed comparison** of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. **Product Data:** including drawings and descriptions of products and fabrication and installation procedures for both the originally specified products and the proposed substitution products.
 - e. **Samples**, where applicable or requested
 - f. **Certificates and qualification data**, where applicable or requested
 - g. **List of similar installations** for completed projects with project names and addresses and names and addresses of architects and owners.
 - h. **Material test reports** from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - i. **Research reports** evidencing compliance with building code in effect for Project, from ICC-ES.
 - j. **Detailed comparison of Construction Manager's construction schedule** using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be

provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

- k. **Cost information**, including a proposal of change, if any, in the Contract Sum.
 - l. **Construction Manager's certification that proposed substitution complies** with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - m. **Construction Manager's waiver of rights to additional payment** or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. **Architect's Action:** If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
 - b. **Use product originally specified if Architect does not issue a decision on use of a proposed substitution within time allocated.**

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

- A. Coordination: Modify or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. **Substitutions for Cause:** Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Architect will consider Construction Manager's request for substitution only when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. **Requested substitution is required due to changed project conditions, unavailability of product, regulatory changes, or unavailability of required warranty items.**
 - b. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - c. Substitution request is fully documented and properly submitted.
 - d. Requested substitution will not adversely affect Construction Manager's construction schedule.
 - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - f. Requested substitution is compatible with other portions of the Work.
 - g. Requested substitution has been coordinated with other portions of the Work.
 - h. Requested substitution provides specified warranty.
 - i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is

compatible with other products, and is acceptable to all contractors involved.

- B. **Substitutions for Convenience: Not allowed, unless otherwise indicated.** If allowed, Architect will consider requests for substitution only if received **within 7 days prior to bid date or date of Guaranteed Maximum Price** being provided to the Owner.

1. Conditions: Architect will consider Construction Manager's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. **Owner's additional responsibilities shall include compensation to Architect for redesign and evaluation services**, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Construction Manager's construction schedule.
 - f. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - g. Requested substitution is compatible with other portions of the Work.
 - h. Requested substitution has been coordinated with other portions of the Work.
 - i. Requested substitution provides specified warranty.
 - j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 012500.13

SUBSTITUTION REQUEST FORM

PROJECT: _____

TO: _____

NO. _____

DATE: _____

Construction Manager hereby requests acceptance of the following product or system as a substitution in accordance with provisions of Division 01 Section 012500 "Substitution Procedures":

1. SPECIFIED PRODUCT OR SYSTEM

Substitution request for: _____

Specification Section No.: _____ Article/ Paragraph: _____

2. REASON FOR SUBSTITUTION REQUEST

SPECIFIED PRODUCT

- ☐ Is no longer available
- ☐ Is unable to meet project schedule
- ☐ Is unsuitable for the designated application
- ☐ Cannot interface with adjacent materials
- ☐ Is not compatible with adjacent materials
- ☐ Cannot provide the specified warranty
- ☐ Cannot be constructed as indicated
- ☐ Cannot be obtained due to one or more of the following:

- ☐ Strike
- ☐ Bankruptcy of manufacturer or supplier
- ☐ Lockout
- ☐ Similar occurrence (explain below)

PROPOSED PRODUCT

- ☐ Will reduce construction time
- ☐ Will result in cost savings of \$ _____ to Project
- ☐ Is for supplier's convenience
- ☐ Is for subcontractor's convenience
- ☐ Other: _____

3. SUPPORTING DATA

- ☐ Drawings, specifications, product data, performance data, test data, and any other necessary information to facilitate review of the Substitution Request are attached.
- ☐ Sample is attached
- ☐ Sample will be sent if requested

4. QUALITY COMPARISON

Provide all necessary side-by-side comparative data as required to facilitate review of Substitution Request:

SPECIFIED PRODUCT

PROPOSED PRODUCT

Manufacturer: _____

Name / Brand: _____

Catalog No.: _____

Vendor: _____

Variations: _____

(Add Additional Sheets If Necessary)

Local Distributor or Supplier: _____

Maintenance Service Available: ☐ Yes ☐ No

Spare Parts Source: _____

Warranty: ☐ Yes ☐ No _____ Years

5. PREVIOUS INSTALLATIONS

Identification of at least three (3) similar projects on which proposed substitution was used:

PROJECT #1

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #2

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

PROJECT #3

Project: _____

Address: _____

Architect: _____

Owner: _____

Contractor: _____

Date Installed: _____

6. EFFECT OF SUBSTITUTION

Proposed substitution affects other work or trades: ☐ No ☐ Yes (if yes, explain)

Proposed substitution requires dimensional revisions or redesign of architectural, structural, M-E-P, life safety, or other work:

☐ No ☐ Yes (if yes, attach data explaining revisions)

7. STATEMENT OF CONFORMANCE OF REQUEST TO CONTRACT REQUIREMENTS

Construction Manager and Subcontractor have investigated the proposed substitution and hereby represent that:

- A. They have personally investigated the proposed substitution and believe that it is equal to or superior in all respects to specified product, except as stated above;
- B. The proposed substitution is in compliance with applicable codes and ordinances;
- C. The proposed substitution will provide same warranty as specified for specified product;
- D. They will coordinate the incorporation of the proposed substitution into the Work, and will include modifications to the Work as required to fully integrate the substitution;
- E. They have included complete cost data and implications of the substitution (attached);
- F. They will pay any redesign fees incurred by the Architect or any of the Architect's consultants, and any special inspection costs incurred by the Owner, caused by the use of this product;
- G. They waive all future claims for added cost or time to the Contract related to the substitution, or that become known after substitution is accepted.
- H. The Architect's approval, if granted, will be based upon reliance upon data submitted and the opinion, knowledge, information, and belief of the Architect at the time decision is rendered and Addendum is issued; and that Architect's approval therefore is interim in nature and subject to reevaluation and reconsideration as additional data, materials, workmanship, and coordination with other work are observed and reviewed.

Contractor: _____
(Name of Contractor)

Date: _____ By: _____

Subcontractor: _____
(Name of Subcontractor)

Date: _____ By: _____

Note: Unresponsive or incomplete requests will be rejected and returned without review.

8. ARCHITECT'S REVIEW AND ACTION

- ☐ Substitution is accepted.
- ☐ Substitution is accepted, with the following comments: _____

- ☐ Resubmit Substitution Request:
 - ☐ Provide more information in the following areas: _____

 - ☐ Provide proposal indicating amount of savings / credit to Owner
 - ☐ Bidding Contractor shall sign Bidder's Statement of Conformance
 - ☐ Bidding Subcontractor shall sign Bidder's Statement of Conformance
- ☐ Substitution is not accepted:
 - ☐ Substitution Request received too late.
 - ☐ Substitution Request received directly from subcontractor or supplier.
 - ☐ Substitution Request not submitted in accordance with requirements.
 - ☐ Substitution Request Form is not properly executed.
 - ☐ Substitution Request does not indicate what item is being proposed.
 - ☐ Insufficient information submitted to facilitate proper evaluation.
 - ☐ Proposed product does not appear to comply with specified requirements.
 - ☐ Proposed product will require substantial revisions to Contract Documents.

By: _____

Date: _____

Architect has relied upon the information provided by the Contractor, and makes no claim as to the accuracy, completeness, or validity of such information. If an accepted substitution is later found to be not in compliance with the Contract Documents, Contractor shall provide the specified product.

END OF FORM

SECTION 012600

CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for handling and processing Contract modifications:**
 - 1. **Minor changes in the Work.**
 - 2. **Proposal requests.**
 - 3. **Change orders.**
 - 4. **Construction change directive.**

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710, Architect's Supplemental Instructions.

1.4 PROPOSAL REQUESTS

- A. **Owner-Initiated Proposal Requests:** Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
 - 2. **Within 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.**
 - a. **Include a list of quantities of products required or eliminated and detailed unit costs**, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Construction Manager's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 - e. **Quotation Form: Use forms acceptable to Architect.**
- B. **Construction Manager-Initiated Proposals:** If latent or changed conditions require modifications to the Contract, Construction Manager may initiate a claim by submitting a request for a change to Architect.
 - 1. **Include a statement outlining reasons for the change and the effect of the change on the Work.** Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. **Include a list of quantities of products required or eliminated and detailed unit costs**, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Construction Manager's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. **Proposal Request Form: Use form acceptable to Architect.**

1.5 ADMINISTRATIVE CHANGE ORDERS

- A. **Allowance Adjustment:** See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
- B. **Unit-Price Adjustment:** See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Proposal Request, Architect will issue a Change Order for signatures of Owner and Construction Manager on AIA Document G701, Change Order.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714, Construction Change Directive. Construction Change Directive instructs Construction Manager to proceed with a change in the Work, for subsequent inclusion in a Change Order.
 1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
 1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 012900

PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements necessary to prepare and process payments:**
 - 1. **Schedule of values.**
 - 2. **Applications for payment.**

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Construction Manager allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Construction Manager's Applications for Payment.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Construction Manager's construction schedule.
 - 1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Submittal schedule.
 - c. Items required to be indicated as separate activities in Construction Manager's construction schedule.
 - 2. **Submit the schedule of values to Architect at earliest possible date, but no later than 15 days before the date scheduled for submittal of initial Applications for Payment.**
- B. **Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.**
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Construction Manager's name and address.
 - e. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703, Continuation Sheet.
 - 3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.

- 2) Materials.
- 3) Equipment.
4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. **Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.**
 - a. Include separate line items under principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
6. **Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.**
 - a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.
7. **Allowances:** Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. **Purchase Contracts:** Provide a separate line item in the schedule of values for each purchase contract. Show line-item value of purchase contract. Indicate owner payments or deposits, if any, and balance to be paid by Construction Manager.
9. Each item in the schedule of values and Applications for Payment shall be complete.
10. **Schedule Updating:** Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
 2. Submit electronically.
 3. Submit updated HUB report with each applications for payment.
- B. **Payment Application Times:** The date for each progress payment is indicated in the Agreement between Owner and Construction Manager. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.
 1. Submit draft copy of Application for Payment **on or before the 20th of each month** for review by Architect.
- C. **Application for Payment Forms:** Use AIA Document G702, Application and Certificate for Payment, and AIA Document G703, Continuation Sheet, as form for Applications for Payment.
- D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Construction Manager. Architect will return incomplete applications without action.
 1. Entries shall match data on the schedule of values and Construction Manager's construction schedule. Use updated schedules if revisions were made.
 2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
 3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
 4. Indicate separate amounts for work being carried out under Owner-requested project acceleration.
- E. **Stored Materials: Include in Application for Payment, amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate**

between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
 2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 3. Provide summary documentation for stored materials indicating the following:
 - a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
 - b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
- F. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.**
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 2. When an application shows completion of an item, submit conditional final or full waivers.
 3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 5. Waiver Forms: Submit executed waivers of lien on forms, acceptable to Owner.
- G. Initial Application for Payment:** Submit electronically. Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. List of subcontractors.
 2. Schedule of values.
 3. Construction Manager 's construction schedule (preliminary if not final).
 4. Schedule of unit prices.
 5. Submittal schedule (preliminary if not final).
 6. List of Construction Manager's staff assignments.
 7. List of Construction Manager's principal consultants.
 8. Copies of building permits.
 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 10. Initial progress report.
 11. Report of preconstruction conference.
 12. Certificates of insurance and insurance policies.
 13. Performance and payment bonds.
 14. Data needed to acquire Owner's insurance.
- H. Application for Payment at Substantial Completion:** Submit electronically. After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion, less 100% retainage, for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
- I. Final Payment Application:** Submit electronically. After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of Project closeout requirements.

2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. Affidavit of Payment of Debts and Claims.
5. Construction Manager's Affidavit of Release of Liens.
6. Consent of Surety to Final Payment.
7. Evidence that claims have been settled.
8. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
9. Final liquidated damages settlement statement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 013100

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative provisions for coordinating construction operations on Project including, but not limited to, the following:**
 - 1. **General coordination procedures.**
 - 2. **Coordination drawings.**
 - 3. **Requests for Information (RFIs).**
 - 4. **Project Web site.**
 - 5. **Project meetings.**

1.3 DEFINITIONS

- A. RFI: Request from Owner, Architect, or Construction Manager seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. **Subcontract List:** Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. **Key Personnel Names:** Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

- A. **Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work.** Coordinate construction operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. **Administrative Procedures:** Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Construction Manager's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.

4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - c. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - d. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - e. Indicate required installation sequences.
 - f. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings as follows:
 1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
 3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
 4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
 5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
 6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
 7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.

- b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
- 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
- 9. Review: Architect will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Construction Manager's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Construction Manager, who shall make changes as directed and resubmit.
- C. **Coordination Digital Data Files:** Prepare coordination digital data files according to the following requirements:
 - 1. **File Preparation Format:** AutoDesk NavisWorks using Revit digital data software program, version, and operating system as original Drawings.
 - 2. **File Submittal Format:** Submit or post coordination drawing files using format same as file preparation format.
 - 3. **BIM File Incorporation:** Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Architect.
 - 4. **Architect will furnish Construction Manager one set of digital data files of BIM Model for use in preparing coordination digital data files in NavisWorks.**
 - a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Construction Manager shall execute a data licensing agreement in the form of Agreement form acceptable to Owner and Architect.

1.7 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Construction Manager shall prepare and submit an RFI in the form specified.
 - 1. Architect will return RFIs submitted to Architect by other entities controlled by Construction Manager with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Construction Manager's work or work of subcontractors.
- B. **Content of the RFI:** Include a detailed, legible description of item needing information or interpretation and the following:
 - 1. Project name.
 - 2. Project number.
 - 3. Date.
 - 4. Name of Construction Manager.
 - 5. Name of Architect.
 - 6. RFI number, numbered sequentially.
 - 7. RFI subject.
 - 8. Specification Section number and title and related paragraphs, as appropriate.
 - 9. Drawing number and detail references, as appropriate.
 - 10. Field dimensions and conditions, as appropriate.
 - 11. Construction Manager's suggested resolution. If Construction Manager's suggested resolution impacts the Contract Time or the Contract Sum, Construction Manager shall state impact in the RFI.
 - 12. Construction Manager's signature.

13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. **RFI Forms:** Software-generated form with substantially the same content as indicated above, acceptable to Architect.
 1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. **Architect's Action:** Architect will review each RFI, determine action required, and respond. **Allow 10 working days for Architect's response** for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.
 1. The following Construction Manager-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Construction Manager's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Architect's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.
 3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Construction Manager to submit Change Proposal according to Section 012600 - Contract Modification Procedures.
 - a. If Construction Manager believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response and prior to beginning of work.
- E. **RFI Log:** Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Software log with not less than the following:
 1. Project name.
 2. Name and address of Construction Manager.
 3. Name and address of Architect.
 4. RFI number including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
- F. On receipt of Architect's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Architect within seven days if Construction Manager disagrees with response.
 1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.8 PROJECT WEB SITE

- A. **Architect will provide and administer a Newforma Project Web site for purposes of hosting and managing project communication and documentation until Final Completion.** Project Web site will include the following functions:
 1. Project directory.
 2. Project correspondence.
 3. Meeting minutes.
 4. Contract modifications forms and logs.
 5. RFI forms and logs.
 6. Task and issue management.
 7. Photo documentation.
 8. Schedule and calendar management.

9. Submittals forms and logs.
 10. Payment application forms.
 11. Drawing and specification document hosting, viewing, and updating.
 12. Online document collaboration.
 13. Reminder and tracking functions.
 14. Archiving functions.
- B. Construction Manager, subcontractors, and other parties granted access by Architect to Project Web site shall execute a data licensing agreement in the form of Agreement acceptable to Architect and Architect.

1.9 PROJECT MEETINGS

- A. **Preconstruction Conference:** Architect will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect.
1. Architect will conduct the conference to review responsibilities and personnel assignments.
 2. **Attendees:** Authorized representatives of Owner, Architect, and their consultants; Construction Manager and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. **Agenda:** Discuss items of significance that could affect progress, including the following:
 - a. Designation of key personnel and their duties.
 - b. Lines of communications.
 - c. Tentative construction schedule.
 - d. Critical work sequencing and long-lead items.
 - e. **Development of BIM coordination model in NavisWorks for coordination of work between trades, G. C., and A/E team.**
 - f. Procedures for processing field decisions and Change Orders.
 - g. Procedures for RFIs.
 - h. Procedures for testing and inspecting.
 - i. Procedures for processing Applications for Payment.
 - j. Submittal procedures.
 - k. Preparation of record documents.
 - l. Use of the premises.
 - m. Work restrictions.
 - n. Working hours.
 - o. Owner's occupancy requirements.
 - p. Responsibility for temporary facilities and controls.
 - q. Procedures for moisture and mold control.
 - r. Procedures for disruptions and shutdowns.
 - s. Construction waste management.
 - t. Parking availability.
 - u. Office, work, and storage areas.
 - v. Equipment deliveries and priorities.
 - w. Security.
 - x. Progress cleaning.
 4. **Minutes:** Architect will record and distribute meeting minutes to each party present and to parties requiring information
- B. **Preinstallation Conferences:** Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction and as required by individual Specification Sections.
1. **Attendees:** Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Owner and Architect of scheduled meeting dates.
 2. **Agenda:** Review progress of other construction activities and preparations for the

particular activity under consideration, including requirements for the following:

- a. Contract Documents.
 - b. Options.
 - c. Related RFIs.
 - d. Related Change Orders.
 - e. Purchases.
 - f. Deliveries.
 - g. Submittals.
 - h. Review of mockups.
 - i. Possible conflicts.
 - j. Compatibility requirements.
 - k. Time schedules.
 - l. Weather limitations.
 - m. Manufacturer's written instructions.
 - n. Warranty requirements.
 - o. Compatibility of materials.
 - p. Acceptability of substrates.
 - q. Temporary facilities and controls.
 - r. Space and access limitations.
 - s. Regulations of authorities having jurisdiction.
 - t. Testing and inspecting requirements.
 - u. Installation procedures.
 - v. Coordination with other work.
 - w. Required performance results.
 - x. Protection of adjacent work.
 - y. Protection of construction and personnel.
3. **Minutes:** Construction Manager shall record and distribute meeting minutes containing significant conference discussions, agreements, and disagreements, including required corrective measures and actions. Distribute minutes of the meeting to each party present and to other parties requiring information.
 4. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
- C. **Project Closeout Conference:** Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
1. Conduct the conference to review requirements and responsibilities related to Project closeout.
 2. **Attendees:** Authorized representatives of Owner, Architect, and their consultants; Construction Manager and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 3. **Agenda:** Discuss items of significance that could affect or delay Project closeout, including the following:
 - a. Preparation of record documents.
 - b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
 - c. Submittal of written warranties.
 - d. Requirements for preparing operations and maintenance data.
 - e. Requirements for delivery of material samples, attic stock, and spare parts.
 - f. Requirements for demonstration and training.
 - g. Preparation of Construction Manager's punch list.
 - h. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
 - i. Submittal procedures.

- j. Owner's partial occupancy requirements.
 - k. Installation of Owner's furniture, fixtures, and equipment.
 - l. Responsibility for removing temporary facilities and controls.
- 4. **Minutes: Construction Manager shall record and distribute the meeting minutes** to each party present and to parties requiring information.
- D. **Owner-Architect-Construction Manager Meetings:** Conduct Owner-Architect-Construction Manager (OAC) meetings at regular intervals.
 - 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. **Attendees:** In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. **Agenda:** Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Construction Manager's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Construction Manager's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - 1) Review schedule for next period.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Temporary facilities and controls.
 - 5) Progress cleaning.
 - 6) Quality and work standards.
 - 7) Status of correction of deficient items.
 - 8) Field observations.
 - 9) Status of RFIs.
 - 10) Status of proposal requests.
 - 11) Pending changes.
 - 12) Status of Change Orders.
 - 13) Pending claims and disputes.
 - 14) Documentation of information for payment requests.
 - 4. **Minutes: Construction Manager shall record and distribute the meeting minutes** to each party present and to parties requiring information unless otherwise directed by the Architect.
 - a. **Schedule Updating: Revise Construction Manager's construction schedule after each progress meeting** where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 013200

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:** Administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. **Startup construction schedule.**
 - 2. **Construction Manager's construction schedule.**
 - 3. **Construction schedule updating reports.**
 - 4. **Daily construction reports.**
 - 5. **Material location reports.**
 - 6. **Site condition reports.**
 - 7. **Special reports.**

1.3 DEFINITIONS

- A. **Activity:** A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. **Critical Activity:** An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. **Predecessor Activity:** An activity that precedes another activity in the network.
 - 3. **Successor Activity:** An activity that follows another activity in the network.
- B. **CPM:** Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- C. **Critical Path:** The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- D. **Event:** The starting or ending point of an activity.
- E. **Float:** The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Construction Manager, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in the following format:
 - 1. PDF electronic file.
- B. **Startup construction schedule.**
- C. **Construction Manager's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.**
- D. Construction Schedule Updating Reports: Submit with Applications for Payment.
- E. Daily Construction Reports: Submit at weekly intervals.
- F. Material Location Reports: Submit at weekly intervals.
- G. Site Condition Reports: Submit at time of discovery of differing conditions.
- H. Special Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE

- A. **Prescheduling Conference: Conduct conference at Project site** to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Construction Manager's construction schedule, including, but not limited to, the following:
1. Review software limitations and content and format for reports.
 2. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial Owner occupancy.
 3. Review delivery dates for Owner-furnished products.
 4. Review schedule for work of Owner's separate contracts.
 5. Review submittal requirements and procedures.
 6. Review time required for review of submittals and resubmittals.
 7. Review requirements for tests and inspections by independent testing and inspecting agencies.
 8. Review time required for Project closeout and Owner startup procedures.
 9. Review and finalize list of construction activities to be included in schedule.
 10. Review procedures for updating schedule.

PART 2 - PRODUCTS

2.1 CONSTRUCTION MANAGER'S CONSTRUCTION SCHEDULE, GENERAL

- A. **Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion and Final Completion.**
- B. **Activities:** Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 10 days, unless specifically allowed by Architect.
 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 3. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
- C. **Constraints:** Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Phasing: Arrange list of activities on schedule by phase.
 2. Work by Owner: Include a separate activity for each portion of the Work performed by Owner.
 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.

- d. Mockups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Startup and placement into final use and operation.
- D. **Milestones:** Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.
 - E. **Upcoming Work Summary:** Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update.
 - F. **Recovery Schedule:** When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Construction Manager intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2.2 STARTUP CONSTRUCTION SCHEDULE

- A. **Bar-Chart Schedule:** Submit startup, horizontal, bar-chart-type construction schedule within seven days of date established for the Notice to Proceed.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction.

2.3 CONSTRUCTION MANAGER'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

- A. General: Prepare network diagrams using AON (activity-on-node) format.
- B. **CPM Schedule:** Prepare Construction Manager's construction schedule using a time-scaled CPM network analysis diagram for the Work.
 - 1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice to Proceed.
 - a. Failure to include any work item required for performance of this Contract shall not excuse Construction Manager from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
 - 2. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
 - 3. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.
- C. **CPM Schedule Preparation:** Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
 - 1. **Activities:** Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
 - a. Mobilization and demobilization.
 - b. Purchase of materials.
 - c. Delivery.
 - d. Fabrication.
 - e. Utility interruptions.
 - f. Installation.
 - g. Work by Owner that may affect or be affected by Construction Manager's activities.
 - h. Testing.
 - i. Punch list and final completion.
 - 2. **Critical Path Activities:** Identify critical path activities, including those for interim

- completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
 4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
- D. **Contract Modifications:** For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.
- E. **Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float."** Identify critical activities. Prepare tabulated reports showing the following:
1. Construction Manager or subcontractor and the Work or activity.
 2. Description of activity.
 3. Main events of activity.
 4. Immediate preceding and succeeding activities.
 5. Early and late start dates.
 6. Early and late finish dates.
 7. Activity duration in workdays.
 8. Total float or slack time.
 9. Average size of workforce.
 10. Dollar value of activity (coordinated with the schedule of values).
- F. **Schedule Updating:** Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.

2.4 THREE WEEK LOOK-AHEAD SCHEDULE

- A. Prepare Construction Manager's 3 Week Look Ahead Schedule outlining each trade that will be working on the site on each day and for each phase of the project. Review at each OAC meeting.

2.5 REPORTS

- A. **Daily Construction Reports:** Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
 2. Approximate count of personnel at Project site.
 3. Equipment at Project site.
 4. Material deliveries.
 5. High and low temperatures and general weather conditions, including presence of rain or snow.
 6. Accidents.
 7. Meetings and significant decisions.
 8. Unusual events (see special reports).
 9. Stoppages, delays, shortages, and losses.
 10. Meter readings and similar recordings.
 11. Emergency procedures.
 12. Orders and requests of authorities having jurisdiction.
 13. Change Orders received and implemented.

14. Construction Change Directives received and implemented.
 15. Services connected and disconnected.
 16. Equipment or system tests and startups.
 17. Partial completions and occupancies.
 18. Substantial Completions authorized.
- B. **Material Location Reports:** At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. **Site Condition Reports:** Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.6 SPECIAL REPORTS

- A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.
- B. **Reporting Unusual Events:** When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Construction Manager's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONSTRUCTION MANAGER'S CONSTRUCTION SCHEDULE

- A. **Construction Manager's Construction Schedule Updating:** At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Construction Manager with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION

SECTION 013233

PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for the following:**
 - 1. **Preconstruction photographs.**
 - 2. **Periodic construction photographs.**
 - 3. ~~**Open wall photographs.**~~
 - 4. **Final completion construction photographs.**

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. **Maintain key plan in latest version of BlueBeam software with each set of construction photographs that identifies each photographic location.**
- B. **Key Plan:** Key plan of Project site and building shall be maintained in latest version of BlueBeam software with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- C. **Digital Images: Digital images in JPG format exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.**
 - 1. **Digital Camera: Minimum sensor resolution of 8 megapixels.**
 - 2. **Format: Minimum 3200 by 2400 pixels with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.**
 - 3. **Identification:** Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Date and time photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.
 - 4. **Field Office Images:** Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- D. **Preconstruction Photographs:** Before starting construction, take not less than 30 digital photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag construction limits before taking construction photographs.
 - 2. Take not less than 20 photographs to show existing conditions adjacent to property before

- starting the Work.
3. Take not less than 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- E. **Periodic Construction Photographs:** Take not less than 30 digital photographs monthly, coinciding with the cutoff date associated with each Application for Payment. During each of the following construction phases, take not less than four of the required shots from same vantage point each time to create a time-lapse sequence as follows:
1. Commencement of the Work, through completion of subgrade construction.
 2. Above-grade structural framing.
 3. Exterior building enclosure.
 4. Interior Work, through date of Substantial Completion.
- F. ~~**Open Wall Photographs:** Allow \$1,500 for an independent photographer to take digital photographs of exterior walls prior to installation of specified cladding and interior walls prior to closing up walls. Capture all utilities and blocking in walls. Attach photos to final PDF as-builts electronically in Bluebeam or similar program. Locate keys geographically correctly on plans.~~
- G. **Final Completion Construction Photographs:** Take not less than 30 digital photographs after date of Substantial Completion for submission as project record documents.
1. Do not include date stamp.
- H. **Additional Photographs:** Owner and Architect may request digital photographs in addition to periodic photographs specified.
1. Three days' notice will be given, where feasible.
 2. In emergency situations, take additional digital photographs within 24 hours of request.
 3. Circumstances that could require additional digital photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

END OF SECTION

SECTION 013300

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Requirements for the submittal schedule and administrative and procedural requirements for submitting following:**
 - 1. **Product Data.**
 - 2. **Shop Drawings.**
 - 3. **Samples**
 - 4. **Other submittals.**

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.4 ACTION SUBMITTALS

- A. **Submittal Schedule:** Submit a schedule of submittals **within 21 days of the notice to proceed**, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Construction Manager's construction schedule.
 - 2. **Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction.** List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. **Final Submittal: Submit concurrently with the first complete submittal of Construction Manager's construction schedule.**
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 - 4. **Format:** Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.
 - g. Scheduled date of fabrication.
 - h. Scheduled dates for purchasing.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. **All Submittals shall be prepared by qualified personnel within the continental United States (no exceptions).** Construction Manager shall require all shop drawings and submittals to be prepared by individuals and firms located within in the Continental United States. Submittals provided by individuals and firms located outside the United States will not be reviewed by the Design Team and will be returned for resubmittal.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 3. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. **Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.**
- C. **Processing Time:** Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. **Initial Review: Allow 15 days for initial review of each submittal.** Allow additional time if coordination with subsequent submittals is required. Architect will advise Construction Manager when a submittal being processed must be delayed for coordination.
 2. **Intermediate Review:** If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. **Resubmittal Review: Allow another 15 days for review of each resubmittal.**
 4. **Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 30 days for initial review of each submittal.**
 5. **Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 21 days for review of each submittal.** Submittal will be returned to Architect before being returned to Construction Manager.
- D. **Electronic Submittals: Submit submittals, except samples, only via Newforma or agreed upon project management software in PDF electronic formatted file.** Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file. Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. **Name file with submittal number or other unique identifier, including revision identifier.**
 - a. **File name shall use project identifier and Specification Section number followed by a hyphen and revision number. (ex. 063000-01r1, 063000-01r2)**
 3. Provide means for insertion to permanently record Construction Manager's review and approval markings and action taken by Architect.
 4. **Transmittal Form for Electronic Submittals:** Use electronic form acceptable to Architect, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Construction Manager.
 - e. Name of firm or entity that prepared submittal.
 - f. Names of subcontractor, manufacturer, and supplier.

- g. Category and type of submittal.
 - h. Submittal purpose and description.
 - i. Specification Section number and title.
 - j. Specification paragraph number or drawing designation and generic name for each of multiple items.
 - k. Drawing number and detail references, as appropriate.
 - l. Location(s) where product is to be installed, as appropriate.
 - m. Related physical samples submitted directly.
 - n. Indication of full or partial submittal.
 - o. Transmittal number.
 - p. Submittal and transmittal distribution record.
 - q. Other necessary identification.
 - r. Remarks.
5. **Metadata:** Include the following information as keywords in the electronic submittal file metadata:
- a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. **Options:** Identify options requiring selection by Architect.
- F. **Deviations and Additional Information:** On an attached separate sheet, prepared on Construction Manager's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. **Resubmittals:** Make resubmittals in same form as initial submittal.
- 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- H. **Use for Construction:** Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. **General Submittal Procedure Requirements:** Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
- 1. **Post electronic submittals as PDF electronic files directly to Newforma or approved Project Web site specifically established for Project.**
 - 2. **Certificates and Certifications Submittals:** Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity and shown in color.
 - 3. Schedule submittals to expedite Project in accordance with approved Construction Schedules and in such sequence as to cause no delay in the Work or in the activities of Owner.
 - 4. **Do not submit bulk or large numbers of submittals at one time, if so submitted, the review time will be extended to length of time required by Architect to properly review bulk submittals.**
 - 5. **Submit related groups of work components such as interior finishes, mechanical, electrical, structural steel, rebar, and concrete together for cross coordination.**
 - 6. **Submittals will be returned without processing if, in the opinion of the Architect:**
 - a. **Submittals were not prepared within the continental United States.**

- b. **Construction Manager has not thoroughly reviewed and coordinated submittal.**
 - c. **Submittals have not been stamped by Construction Manager for coordination of the Work and conformance with the Drawings and Specifications prior to submission to Architect.**
 - d. **Submittals are not initialed or signed by authorized person.**
 - e. **Submittals are not dated.**
 - f. **Submittals are not provided in related groups.**
 - g. **Large and multiple submittals are submitted to the A/E not allowing adequate time to review them all with the prescribed time limits.**
 - h. **Items to be used are not specifically marked as being the selected product.**
- 7. **Do not perform Work on any element of the Work requiring submittal and review of shop drawings, product data, samples, or other similar submittals until respective submittal has been approved by Architect (No Exceptions!).**
- B. **Product Data:** Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - 2. **Mark each submittal to show which specific products and options are being submitted for use on this project.**
 - 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
- C. **Shop Drawings:** Prepare Project-specific information, drawn accurately to scale. **Do not base Shop Drawings on reproductions of the Contract Documents** or standard printed data, unless submittal based on Architect's digital data drawing files is otherwise permitted on a signed licensing agreement and \$25.00 transfer fee has been provided.
 - 1. **Preparation:** Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 - 2. **Sheet Size:** Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
- D. **Samples:** Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
 - 1. **Where samples and final products are required to match Architect's sample, obtain sample from Architect prior to matching and selecting of final vendor.**
 - 2. **Transmit Samples that contain multiple, related components such as accessories**

- together in one submittal package.**
3. **Identification:** Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.
 - d. **Number and title of applicable Specification Section.**
 - e. Specification paragraph number and generic name of each item.
 4. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
 5. **Disposition:** Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Construction Manager.
 6. **Samples for Initial Selection:** Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. **Number of Samples:** Submit at least **three full sets** of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
 7. **Samples for Verification:** Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. **Number of Samples:** Submit at least **three sets** of Samples. Architect will retain one Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record sample.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
 - E. **Coordination Drawing Submittals:** Comply with requirements specified in Section 013100 "Project Management and Coordination."
 - F. **Construction Manager's Construction Schedule:** Comply with requirements specified in Section 013200 "Construction Progress Documentation."
 - G. **Application for Payment and Schedule of Values:** Comply with requirements specified in Section 012900 "Payment Procedures."
 - H. **Test and Inspection Reports and Schedule of Tests and Inspections Submittals:** Comply with requirements specified in Section 014000 "Quality Requirements."
 - I. **Closeout Submittals and Maintenance Material Submittals:** Comply with requirements specified in Section 017700 "Closeout Procedures."
 - J. **Maintenance Data:** Comply with requirements specified in Section 017823 "Operation and Maintenance Data."
 - K. **Qualification Data:** Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

- L. **Welding Certificates:** Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- M. **Installer Certificates:** Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- N. **Manufacturer Certificates:** Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- O. **Product Certificates:** Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- P. **Material Certificates:** Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- Q. **Material Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- R. **Product Test Reports:** Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- S. **Research Reports:** Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- T. **Preconstruction Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- U. **Compatibility Test Reports:** Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- V. **Field Test Reports:** Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- W. **Design Data:** Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

- A. **Performance and Design Criteria:** Where professional design services or certifications by a design professional are specifically required of Construction Manager by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. **Delegated-Design Services Certification:** In addition to Shop Drawings, Product Data, and

other required submittals, submit digitally signed PDF electronic file of certificate, signed in color and sealed by the responsible design professional, for each product and system specifically assigned to Construction Manager to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONSTRUCTION MANAGER'S REVIEW

- A. **Action and Informational Submittals:** Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. **Project Closeout and Maintenance Material Submittals:** See requirements in Section 017700 "Closeout Procedures."
- C. **Approval Stamp:** Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Construction Manager's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. **Action Submittals:** Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
 1. Submittals stamped **"No Exception Taken"**: No corrections or resubmittal required; fabrication may proceed.
 2. Submittals stamped **"Make Corrections Noted"**: Comply with noted corrections and modifications; and proceed with the Work. If for any reason noted corrections and modifications cannot be fully complied with, resubmit for review requesting clarification; do not proceed with fabrication. When submittals are returned with "Make Corrections Noted" stamp, do not resubmit the noted corrections for re-review unless the original submittal contains additional information, revisions, or the original noted corrections cannot be incorporated.
 3. Submittals stamped **"Rejected"** or **"Revise and Resubmit"**: Revise and resubmit for review; do not proceed with fabrication. Clearly indicate revisions, including corrections, to previous submittal. **Disapproved submittals will not be considered valid cause for construction delay.**
- B. **Informational Submittals:** Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- D. **Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.**
- E. Catalog cuts or product selection pages that are not fully marked as to the exact model, size, color, or other information specific to the item being used on this project will be returned as incomplete.
- F. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION

SECTION 014000

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for quality assurance and quality control.**
- B. **Mock-ups.**

1.3 DEFINITIONS

- A. **Quality-Assurance Services:** Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. **Quality-Control Services:** Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. **Mockups:** Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
- D. **Preconstruction Testing:** Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. **Product Testing:** Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. **Source Quality-Control Testing:** Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. **Field Quality-Control Testing:** Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- H. **Testing Agency:** An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. **Installer/Applicator/Erector:** Construction Manager or another entity engaged by Construction Manager as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. **Experienced:** When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 TESTING AND INSPECTING SERVICES

- A. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Construction Manager of responsibility for compliance

with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Construction Manager's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Construction Manager to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.5 CONFLICTING REQUIREMENTS

- A. Referenced Standards: **If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement.** Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 INFORMATIONAL SUBMITTALS

- A. Construction Manager's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Construction Manager's quality-control personnel.

1.7 CONSTRUCTION MANAGER'S QUALITY-CONTROL PLAN

- A. **Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference.** Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Construction Manager's quality-assurance and quality-control responsibilities. Coordinate with Construction Manager's construction schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- E. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

- A. **Test and Inspection Reports:** Prepare and submit certified written reports specified in other Sections. Include the following:
 1. Date of issue.

2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. **Manufacturer's Technical Representative's Field Reports:** Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. **Factory-Authorized Service Representative's Reports:** Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.
- D. **Permits, Licenses, and Certificates:** For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. **Manufacturer Qualifications:** A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- C. **Fabricator Qualifications:** A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing

engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

- F. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- G. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- H. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Construction Manager responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - 2. **Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect,** with copy to Construction Manager. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- J. **Mockups:** Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed unless otherwise indicated.
 - 8. **Integrated Exterior Mockup:** Provide mockup of the exterior envelope erected separately from the building but on the project site. Mockup consists of multiple products, assemblies, and sub-assemblies. At a minimum, the Integrated Exterior Mockup shall include each type of exterior finish including brick, terra cotta cast stone, curtain wall, fixed aluminum windows, glazing, coping, Spanish tile roofing, metal panels, gutter, downspout, mortar and sealants. Mock-up shall include stud backup materials, with

sheathing, air barrier, flashings, masonry ties, etc. Refer to drawings for other requirements. **Allowance for Integrated Exterior Mockup shall be \$30,000.00.**

9. **Interior Finishes Mockups:** Provide a separate 8' by 8' mockup of each interior painted wall color used on the project depicting the paint. Include backup construction in the mock-up.

1.10 QUALITY CONTROL

- A. **Owner Responsibilities:** Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 1. Owner will furnish Construction Manager with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Construction Manager, and the Contract Sum will be adjusted by Change Order.
- B. **Construction Manager Responsibilities:** Tests and inspections not explicitly assigned to Owner are Construction Manager's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Construction Manager by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Construction Manager's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Construction Manager shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality-control services are indicated as Construction Manager's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 5. Testing and inspecting requested by Construction Manager and not required by the Contract Documents are Construction Manager's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- D. **Manufacturer's Technical Services:** Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Construction Manager's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. **Testing Agency Responsibilities:** Cooperate with Architect and Construction Manager in performance of duties. Provide qualified personnel to perform required tests and inspections.
 1. Notify Architect and Construction Manager promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report of each test, inspection, and similar quality-control service through Construction Manager.

5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Construction Manager.
- G. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. **Schedule of Tests and Inspections:** Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Construction Manager's quality-control plan. Coordinate and submit concurrently with Construction Manager's construction schedule. Update as the Work progresses.

1.11 **BUILDING ENVELOPE CONSULTANT AND TESTING AGENCIES**

- A. **If not provided by Owner, Construction Manager shall engage a qualified and experienced building envelope consultant** to review the envelope details and specifications and to provide periodic testing and inspections of the building envelope.
- B. The purpose of the building envelope consultant is to provide an independent, third-party verification that the installed performance of the building enclosure meets or exceeds the minimum performance requirements set forth by the Contract Documents.
- C. Responsibilities of Consultant:
 1. Review Contract Documents detailing and specifications and make recommendations if needed.
 2. Review building envelope submittals for compliance with Contract Documents.
 3. Periodically witness installation of various aspects of the building envelope assembly.
 4. **Components to be tested and inspected:**
 - a. **Vertical waterproofing.**
 - b. **Below grade vapor retarder.**
 - c. **Cold-formed metal framing with sheathing and fluid-applied membrane air barrier.**
 - d. **Unit masonry, terra cotta cladding, and cast stone masonry.**
 - e. **Glazed aluminum curtain walls, entrances, storefronts, fixed aluminum windows, and glazing.**
 - f. **Joint sealants.**
 - g. **Spanish clay tiles, modified bitumen and metal roofing, associated flashings, and metal wall panels.**
 5. Prepare and maintain the exterior enclosure construction deficiencies log. Promptly notify Architect and Construction Manager of irregularities or deficiencies in work that are observed during the performance of services.

1.12 **SPECIAL TESTS AND INSPECTIONS**

- A. **Special Tests and Inspections: Conducted by a qualified testing agency or special**

inspector as required by the Project Specifications or the Authorities Having Jurisdiction (AHJ), as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect and Construction Manager promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Construction Manager and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. **Test and Inspection Log:** Prepare a record of tests and inspections. Include the following:
 1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 - Execution.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Construction Manager's responsibility, regardless of the assignment of responsibility for quality-control services.

3.3 SCHEDULE OF TESTING

- A. Provide all testing required in individual specification sections including, but not limited to:
 1. Masonry grout.
 2. Air barrier membrane thickness and air leakage.
 3. Cast-in-place concrete: slump, air entrainment, temperature as required by ACI, structural engineer and codes.
 4. Below and above grade waterproofing and dampproofing.
 5. Window testing (vacuum chamber and hose stream as specified).
 6. Slab surface moisture testing.
 7. Grout slump and compressive strength.
 8. Mortar slump and compressive strength.

END OF SECTION

SECTION 014200

REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. **"Approved"**: When used to convey Architect's action on Construction Manager's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. **"Directed"**: A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. **"Indicated"**: Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. **"Regulations"**: Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. **"Furnish"**: Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. **"Install"**: Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. **"Provide"**: Furnish and install, complete and ready for the intended use.
- I. **"Project Site"**: Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - 1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."
- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities. Retain "Federal Government Agencies" Paragraph below if required. The Section Text in MasterSpec Sections is prepared assuming list is retained.

- C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities.
- D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations.
- E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 015000

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Requirements for following:**

1. **Temporary utilities.**
2. **Support facilities.**
3. **Security and protection facilities.**

1.3 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, testing agencies, and authorities having jurisdiction.
- B. **Sewer Service:** Owner will pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. **Water Service:** Owner will pay water-service use charges for water used by all entities for construction operations.
- D. **Electric Power Service:** Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.

1.4 QUALITY ASSURANCE

- A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. **Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines, ICC/ANSI A117.1, and applicable accessibility standards.**

1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. **Portable Chain-Link Fencing:** Minimum 2 inch, 0.148 inch thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8 inch OD line posts and 2-7/8 inch OD corner and pull posts, with 1-5/8 inch OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

2.2 TEMPORARY FACILITIES

- A. **Field Offices,** General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

- B. **Common-Use Field Office:** Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. **Conference room of sufficient size to comfortably accommodate meetings of 10 individuals or more.** Provide electrical power service and 120-V ac duplex receptacles, with no fewer than two receptacles on each wall. Furnish room with conference table, 10 chairs, 4 foot square tack and marker boards, **60 inch flat screen monitor and computer with BlueBeam, Revit, NavisWorks, and other applicable software** to view drawings and specifications during OAC meetings.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
 - 6. Lighting fixtures capable of maintaining average illumination of 40 fc at desk height.
- C. **Storage and Fabrication Sheds:** Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - 1. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. **Fire Extinguishers:** Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. **HVAC Equipment:** Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. **Heating Units:** Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
 - 3. **Permanent HVAC System: If Owner authorizes use of permanent HVAC system** for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 - Closeout Procedures.
 - 4. **Dehumidification Equipment:** Refer to Section 015300 for type and required use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
- B. **Provide each facility ready for use when needed to avoid delay.** Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. **Sewers and Drainage:** Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. **Water Service:** Install water service and distribution piping in sizes and pressures adequate for construction.
- D. **Sanitary Facilities:** Provide temporary toilets, wash facilities, and drinking water for use of

construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

- E. **Heating:** Provide temporary heating required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. **Ventilation and Humidity Control:** Provide temporary ventilation and dehumidification equipment as required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- G. **Electric Power Service:** Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
- H. **Lighting:** Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install lighting for Project identification sign.
 - 3. **Lighting during tile installation: Provide a minimum of 70 fc during installation of all tile work.**
- I. **Telephone Service:** Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office.
 - 1. Provide additional telephone lines for the following:
 - a. Provide a dedicated telephone line for each facsimile machine in each field office.
 - b. Provide one telephone line(s) for Owner's use.
 - 2. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Construction Manager's home office.
 - d. Construction Manager's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Owner's office.
 - g. Principal subcontractors' field and home offices.
 - 3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- J. **Electronic Communication Service:** Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:
 - 1. Processor: Intel Pentium D or Intel CoreDuo, 3.0 GHz processing speed.
 - 2. Memory: 4 gigabyte.
 - 3. Disk Storage: 500 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.
 - 4. **Display: 60 inch LCD monitor with 256-Mb dedicated video RAM.**
 - 5. Full-size keyboard and mouse.
 - 6. **Network Connectivity: 10/100BaseT Ethernet hard wired to ISP network (not satellite based).**
 - 7. Operating System: Microsoft Windows Vista Business.
 - 8. **Productivity Software:**
 - a. Microsoft Office, including Word, Excel, and Outlook.
 - b. Adobe Reader 7.0 or higher.
 - c. WinZip 7.0 or higher.
 - d. **BlueBeam drawing and document management software.**
 - e. **AutoDesk Revit, latest editions.**
 - f. **AutoDesk NavisWorks, latest edition.**
 - 9. Printer: "All-in-one" unit equipped with printer server, combining color printing,

- photocopying, scanning, and faxing, or separate units for each of these three functions.
10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 384 Kbps upload and 1 Mbps download speeds at each computer.
 11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 12. Backup: External hard drive, minimum 40 gigabyte, with automated backup software providing daily backups.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Comply with the following:
 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
 2. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. **Temporary Roads and Paved Areas:** Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
 1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- C. **Traffic Controls:** Comply with requirements of authorities having jurisdiction.
 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. **Parking:** Provide temporary parking areas for construction personnel.
- E. **Project Signs:** Provide Project signs as specified herein. Unauthorized signs are not permitted.
 1. **Identification Signs:** Provide **two Project identification signs** of the type indicated on Drawings located at the corners of the site as directed by the Architect.
 - a. Signs shall be **8 foot square** and constructed of 2 sheets of 4' by 8' CDX plywood with **three 15' tall 4 inch by 4 inch treated wood posts** set in 36 inch deep by 12 inch diameter concrete piers. Sign shall be printed on exterior media by a reputable sign maker with the high resolution graphics file provided by the Architect.
 2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 3. Maintain and touchup signs so they are legible at all times.
- F. **Waste Disposal Facilities:** Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 - Execution.
- G. **Existing Elevator Use (Where Applicable):** Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
 1. Do not load elevators beyond their rated weight capacity.
 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- H. **Temporary Use of Permanent Stairs:** Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. **Protection of Existing Facilities:** Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. **Environmental Protection:** Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. **Temporary Erosion and Sedimentation Control:** Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. **Stormwater Control:** Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. **Tree and Plant Protection:** Install fixed (non-movable) temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. **Pest Control:** Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.
- G. **Site Enclosure Fence:** Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
 - 2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- H. **Security Enclosure and Lockup:** Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.
- I. **Barricades, Warning Signs, and Lights:** Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. **Temporary Egress:** Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. **Temporary Enclosures:** Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- L. **Temporary Partitions:** Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate occupied areas from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - 2. Construct dustproof partitions with two layers of 6 mil polyethylene sheet on each side. Overlap and tape full length of joints.
 - 3. Protect air-handling equipment.
 - 4. Provide walk-off mats at each entrance through temporary partition.

- M. **Temporary Fire Protection:** Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.5 OPERATION, TERMINATION, AND REMOVAL

- A. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- B. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
1. Materials and facilities that constitute temporary facilities are property of Construction Manager. Owner reserves right to take possession of Project identification signs.
 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 - Closeout Procedures.

END OF SECTION

SECTION 015300

MOLD PREVENTION MEASURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

- 1. **Administrative and procedural requirements to help prevent mold contamination during and after construction.**

1.3 SUBMITTALS

- A. Reports: Submit reports required in this Section, including but not limited to the following:
 - 1. Sightings of existing mold.
 - 2. Moisture contents of materials.
 - 3. Exterior sealant cracks, damage, and deterioration.

1.4 QUALITY ASSURANCE

- A. **Preconstruction Meeting: Review requirements of this Section at Preconstruction Meeting.**

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
- B. **Do not bring gypsum board and other finishes materials into building until building is "dried in" or in an environmentally conditioned state. Protect finish materials stored within building. Stage materials off the floor and cover with waterproof covering. Examples of these materials include, but are not limited to, insulation, gypsum products, wall coverings, carpet, acoustical ceiling panels, millwork, wood products, etc.**
- C. **Remove damaged materials or materials that have become wet from construction, such as wood, insulation, gypsum board or finishes within 24 hours. Do not install or allow such materials to remain in the building after getting wet.**

1.6 PROJECT CONDITIONS

- A. **Remove water found within building during construction immediately, but no later than 24 hours.**
 - 1. Energize lift stations and sump pumps as early in Project as possible. Use temporary pumps if necessary to get water out of building and drain lines.
- B. **Ventilation: Provide temporary outside air ventilation as building becomes enclosed.**
- C. **Maintain a clean project site, free from hazards, garbage, food, and debris.**
- D. **Eating, drinking, and smoking are not permitted within building.**
- E. **Slope perimeter grades, both temporary and final, away from the building structure to provide positive drainage during construction.**
- F. Verify that condensate pans drain properly beginning with initial installation.
- G. Flash roof penetrations immediately. Do not allow water to penetrate through them to areas below.
- H. **Seal window openings prior to window installation with plastic to prevent entry of rain.**
- I. **Cover stored and installed ductwork and installed duct openings with plastic to prevent dust, debris, and moisture from entering ductwork. Repair damaged plastic protection on a daily basis.**

- J. Do not operate air handling equipment below 60 degrees F supply air temperature until building is 100 percent enclosed.
- K. Monitor humidity and temperature for conformance to installation requirements defined by material and equipment manufacturers.
- L. **Check moisture content of gypsum board prior to applying finishes. Record findings and forward to the Architect prior to installing finishes.**

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be by trained professional
- B. **Floor Drains:** Connect floor drains as soon as possible. Do not cover floor drains with tape or other obstructions during construction. Clean out floor drain lines to mains prior to Substantial Completion.
- C. **Moisture-Resistant Gypsum Wall Board (GWB):** Install fiberglass faced moisture resistant GWB on room side of all exterior walls where GWB is called for on documents. Provide fiberglass faced moisture resistant GWB at all restrooms, janitor closets and other areas where moisture and/or plumbing fixtures are present.
- D. **Wall Assemblies:**
 - 1. Install exterior batt insulation (if specified), vapor retarder, and interior gypsum board only after building is dried in.
 - 2. Keep bottom of installed gypsum board off floor 1/2 inch so as not to wick moisture off the slab.
- E. **Cavity Conditions: Clean and inspect cavity conditions prior to covering, sealing, or restricting access. Vacuum cavity spaces prior to enclosing.**
- F. **Plumbing:** Pressure test plumbing piping identified as insulated on Project prior to installation of insulation.
- G. **Roof Mounted Equipment:** Inspect rooftop units and other roof-mounted equipment for rain leaks immediately after first rain. **Water test base flashings and roof curbs in the presence of Architect with hose immediately after installation.** Seal leaks immediately.
- H. **Sealants:** Inspect exterior sealants for cracks, damage, or deterioration. Record findings and forward to Architect. Repair as needed.
- I. **HVAC Equipment (Permanent HVAC Equipment Used for Temporary Conditioning of Building During Construction Phases):** Install manufacturer approved HEPA or MERV filters when used for temporary conditioning activities. Provide MERV of 8 filters on return air grilles until Substantial Completion or testing of equipment occurs. Change filters and clean ductwork interior to remove dirt, dust, debris, and moisture buildup during construction.
- J. **Water test 25% of exterior windows and 100% of curtainwall installations in building. Leave drywall finishes off of interior side of window, curtainwall and storefront heads, jams, and sills until testing is complete to allow for visual inspection of leaks. Perform hose stream tests on the windows, storefronts and curtain walls. Employ window testing firm approved by the Owner and Architect.**

3.2 ADJUSTING

- A. Remove damaged materials or materials that have become wet. Replace with new materials.

3.3 DEMONSTRATION, WARRANTY AND TRAINING

- A. **Train and educate Owner's maintenance personnel on proper use of building systems. Explain how improper operation and shutting down systems during off periods (such as warmer summer months) can create mold problems.**
- B. Review building for mold problems during the 1-year warranty walk-through. Inspect exterior sealants and masonry joints for cracks and other damage or deterioration where water can penetrate building envelope, during the 1-year warranty walk-through

- C. Explain to Owner the need to establish annual building review for mold and roof maintenance.

END OF SECTION

SECTION 015634

TREE AND PLANT PROTECTION, REMOVAL, AND PRUNING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Contractor shall provide protection of existing trees or other designated plant material in order to maintain a healthy, vigorous condition.
- B. The Contractor shall perform tree removal and pruning as specified, utilizing acceptable horticultural standards as adopted by the Texas Association of Landscape Contractors (TALC) or Texas Nurseryman Association. Such work shall include, but is not limited to, the following:
 - 1. Protection of existing trees to remain.
 - 2. Root pruning of existing trees to remain adjacent to new pavement construction.
 - 3. Pruning of tree branches and canopy adjacent to allow construction and access.
 - 4. Transplanting of trees to new locations on site. - NOT USED
 - 5. Pruning or repairing trees damaged due to site demolition operations.
 - 6. Replacement of trees severely damaged by construction work.
 - 7. Watering and fertilizing of existing trees to remain and transplanted trees.
- C. Alternates: Refer to the drawings and Division 1 Section "Alternates" for description of Work in this Section affected by alternates.

1.2 INSPECTION OF THE SITE

- A. The Contractor shall visit the site to inspect the conditions with the Owner's Representative prior to commencing work.
- B. The Contractor shall verify with the Owner's Representative the extent of existing tree protective fencing and addition or replacement of the existing protection fencing.
- C. Utilities: Determine locations of underground utilities and perform work in a manner which is intended to avoid possible damage. Hand excavate, where required, to minimize possibility of damage to underground utilities.

1.3 SEQUENCING

Coordinate installation of protection devices and other related units of Work specified in other Sections to ensure that protection of existing trees is complete prior to any on site staging or construction.

1.4 SUBMITTAL – PHOTO DOCUMENTATION

Submit a written and photographic inspection report of status of each tree to be preserved including, but not limited to, observed status of health, damage, and signs of insect, disease, mite, pests, mistletoe, mosses, lichen. Submit four (4) copies in 8-1/2 x11 format with trees numbered to corresponding site plan. Use a digital camera with at least 5.0 megapixels of resolution to document observations. Submit photo documentation prior to commencing demolition in three-hole binder.

PART 2 - PRODUCTS

2.1 WOUND PAINT

For trees within protection fencing area that may have received damage due to adjacent clearing. Petroleum or latex base tree wound paint, dark gray, brown or black in color. Spray type paints are acceptable for use on genus Quercus only.

2.2 TREE PROTECTION FENCING

Refer to the drawings for the location of proposed tree protection fencing. If not noted on the plans, then the Contractor to provide type of fencing at his discretion to preserve trees and maintain access for maintenance and inspection.

Types of fencing:

A. Non-movable fencing:

1. All elements hot dip galvanized unless otherwise shown.
2. All elements consist of the following:
 - a. Chain link fencing: Nine gauge, 2 inch mesh, 4 foot height.
 - b. Posts: 2-3/8 inches outside diameter, minimum, set 2 foot into ground.
 - c. Brace rails: 1-5/8 inches outside diameter, minimum.
 - d. Stretcher bars: 1/4 inch by 3/4 inch, minimum.

B. Movable Chain Link fencing:

1. All elements hot dip galvanized unless otherwise shown.
2. All elements consist of the following:
 - a. Chain link fencing: Nine gauge, 2 inch mesh, 4 foot height.
 - b. Posts: 2-3/8 inches outside diameter, minimum, 5 foot long.
 - c. Brace rails: 1-5/8 inches outside diameter, minimum.
 - d. Stretcher bars: 1/4 inch by 3/4 inch, minimum.
 - e. Footing: Old tire filled with concrete for setting of posts.
3. Movable Chain Link fencing: Contractor may provide alternate approved type of movable chain link fencing.

C. Orange safety netting:

1. 4' orange safety netting
2. Metal T-posts minimum four (4) foot length placed a minimum eight (8) feet on center

D. Temporary enclosures and wrapping

1. The Contractor shall protect tree trunks and root zones from damage. If fencing is not possible due to proximity of construction, then the Contractor is obligated to wrap the trunk with material sufficient to protect the trunk from any damage. The Contractor is obligated to protect the root zone from compaction and damage. The Contractor may use 2x4 pieces wired together to protect the trunk to a minimum height of eight (8) feet above grade. Mulch, gravel and plywood boards may be used to cover 100% of the root zone.

E. Miscellaneous materials: burlap, coarsely shredded hardwood mulch, septic (rounded) gravel.

2.3 MATERIALS

- A. Mulch: Coarsely shredded hardwood mulch that has been decomposing or composting for a minimum of 60 days and graded to eliminate large size materials from passing the screen.
- B. Fertilizers for Trees: Fertilize all trees with a combination of PHC for trees 27-9-9 and Mycor

Tree Injectable. Mix 8 pounds of PHC for trees and A and B packets of Mycor Tree Injectable per one hundred (100) gallons of water.

- C. Herbicides, Insecticides, Miticides and Fungicides: Legal commercial quality non-staining materials with original manufacturers' containers, properly labeled with guaranteed analysis, least toxic required.
- D. Water: Clean fresh, free of substances toxic to plant growth.
- E. Sterilant: Use a horticultural accepted sterilant for sterilizing pruning equipment.

2.4 MACHINERY AND EQUIPMENT

Machinery or tools requirements listed under this Section are NOT intended to be restrictive of specific manufacturers or models, unless so stated. Specific mention of the manufacturers is intended as a guide to illustrate the final product of the maintenance operations desired. All equipment used shall be and maintained in top working condition at all times

- A. Pruning tools shall be maintained in safe, working condition, cutting edges shall be sharp at all times.
- B. Use sharp axe for root pruning.

2.5 REPLACEMENT TREES

- A. Trees that are designated to remain or transplant and that are severely damaged, in significant decline or have died during construction shall be replaced by the Contractor at the Contractor's expense according to the values below. The Owner's Representative shall determine if replacement is necessary.
- B. Trees determined to be replaced that are 8 inch caliper or less shall be replaced with a new tree of same size and species. Owner's representative will assess the following damages for damaged, dead or dying, or removed trees to be paid by the Contractor to the Owner.

<u>Tree size – Diameter</u>	<u>Replacement Value</u>
<u>In inches</u>	<u>Each tree</u>
Greater than 8 and up to 12	\$3,000.00
Greater than 12 and up to 15	\$4,000.00
Greater than 15 inches	\$ 300.00 per caliper inch

- C. Size will be determined by measuring caliper at 12 inches above grade for trees from 4 to 12 inch caliper and at 6 inches above grade for trees from 0 to 4 inch in caliper. Trees determined to be replaced that are larger than 12 inch in caliper shall be measured at 4 feet above natural ground elevation, or from top of stump, if removed.

PART 3 - EXECUTION

3.1 PERSONNEL

The Contractor shall furnish personnel licensed in the removal of trees cleared from the site.

3.2 FIELD VERIFICATION

The Contractor shall field verify with the Owner's Representative trees to be removed prior to commencing work.

3.3 TREE PRESERVATION

- A. Protect trees with tree protective fencing prior to tree removal. Install tree protective fencing past the tree drip line to protect limbs from trucks and moving objects, unless designated

otherwise on the drawing. Provide gate for access to monitor and maintain tree. Install posts eight (8) feet on center.

B. TREE PROTECTION MUST OCCUR PRIOR TO ANY SITE WORK, DEMOLITION OR GRADING.

- C. Tree protection must receive approval of the Owner's Representative prior to starting any site work.
- D. Repair injuries, abrasions and other damage to plants by cleanly removing broken members, loose and torn bark, and shape edges in order to permit drainage of rain water from wounds. Paint wounds with an approved tree wound paint.
- E. Prune branches of trees adjacent to equipment access route and equipment adjacency to trees to remain to prevent damage to canopy per approved horticultural practices.
- F. Where depth of soil over root system of existing plantings is to be modified by final grading, provide the following:
 - 1. Where increase of one (1) foot or more in elevation is shown, spread continuous layer of rock aggregate, graded one-quarter (1/4) inch to two (2) inches, six (6) inches deep from trunk to drip line of branches prior to installation of fill.
 - 2. Provide proper aeration by installing within perimeter of spread, a system of four (4) inch clay drain tile. Install vertically flush with soil surface and penetrating into layer of aggregate fill.
- G. Do not clean construction equipment, dump liquids, nor perform field maintenance on vehicles in the vicinity of the trees to be preserved.
- H. Root prune all trees adjacent to new construction at line of tree protection fencing as shown on the drawings. Use an irrigation trencher set at eighteen (18) inch depth to trench across area parallel to the extent of the tree protection fence location. Maintain fifteen (15) foot clear minimum from tree trunk unless shown otherwise on drawings.
- I. Apply two (2) inches of coarsely shredded hardwood mulch over tree root zone within fencing.

3.4 BORING NEAR TREES

- A. Bores within the root zone of large trees shall be horizontal directional bores. For pipe installation, mechanically bore the tunnel under the roots with a horizontal directional drill and hydraulic or pneumatic air excavation technology. In all cases, install the utility pipe immediately, backfill with soil and soak within the same day. Installation shall be tunnel bored beneath the tree and roots per the following chart:

Trenching Distance	
When the Tree Diameter (at 4.5' height) is	Trenching will be Replaced with Boring at this Min. Distance (10x tree diameter) from the Face of the Tree in any Direction
6-9" measured at 6"	5- 8'
10-14" measured at 54"	10 - 13'
15-19" measured at 54"	14- 16'
19-24" measured at 54"	17-19'
Over 25" measured at 54"	20'+

Depth of Tunneling	
9" or less measured at 6"	2.0'

10-14" measured at 54"	2.5'
15-19" measured at 54"	3.0'
More than 19" measured at 54" depth of tunnel	3.5'

Bore pits shall be located at a minimum distance as specified by trenching distance table above.

3.5 TREE REMOVAL

- A. Obtain Tree Removal Permit as required by the City trees to be removed as shown on the drawings.
- B. Receive approval from the Owner's Representative in the field for trees to be removed. Trees that have died or have been approved for removal shall be removed by felling with chain saws. Fell trees to avoid injuring protected trees and undergrowth or damaging utilities. Use felling methods that comply with OSHA and American Association of Nurserymen.
- C. Burning and burying debris on the Worksite is prohibited.
- D. Grind stumps and roots to depth of eighteen (18) to twenty-four (24) inches within four (4) feet radius of tree.
- E. Haul off and legally dispose of debris.

3.6 WATERING

- A. Deep root water existing tree(s) with protection fencing once every two weeks during the summer and once a month during the winter, during the duration of the project and until final acceptance. This should be adjusted to the amount of rain. However, unless it has rained at least one-half (1/2) inches since the last watering, continue to deep root water.
- B. Using a soil probe to check root ball moisture and surrounding soil moisture at each tree at least twice a week.
- C. Maintain watering saucers around trees so that enough water can be applied to establish moisture through root zones. Open saucers to allow surface drainage away from the root crown when excess water accumulates. Restore watering saucers when needed to adequately water root balls. Remove watering saucer berms at the end of the maintenance period and form mulch area around trees.
- D. Adjust frequency and length of time for watering cycles according to changing soil and weather conditions. Apply supplemental water to watering saucers by hand using a hose and water wand to break the water force if for any reason the temporary irrigation system is not providing adequate moisture.
- E. Do not permit crown roots to become exposed to air through dislodging of soil and mulch. Maintain depth of four (4) inches of mulch to reduce evaporation and frequency of watering.

3.7 MAINTENANCE OF EXISTING TREES

- A. Trees shall be continuously and routinely inspected for distress caused by construction activities. Notify Owner's representative at first sign of distress.
- B. Any Fire Ant mounds around or on top of a tree root zone shall be treated immediately and the mound removed physically. Do not allow the mound to build on the tree trunk as this will cover the tree root flare and possibly cause injury or death. Insure that any chemical application to the Fire Ant mound is safe for application atop tree root zones. Ant mounds do not need to be treated in tree masses.
- C. Trees: Pruning will be carried out by experienced pruning personnel.
 1. Receive approval in the field for extent of pruning of damaged trees from Owner's Representative.

2. Sterilize pruning tools with hydrogen peroxide or alcohol between individual plants, especially in the genus *Quercus*. Paint all wounds on plants of the genus *Quercus* with wound paint as soon as possible. Paint deliberate wounds (pruning) within 1 hour. Paint accidental wounds (storm or equipment damage or vandalism) as soon as they are observed.
3. Remove branches larger than two (2) inch in diameter with three (3) step cut.
4. Pruning will be carried out by experienced pruning personnel.
5. Raise limbs to an acceptable height as approved by the Owner's Representative. Raise limbs to seven foot height for trees within 10 feet of parking or sidewalk.
6. No weed-eaters or edgers are to be used within fifteen (15) inches of any tree. Should the need for trimming be necessary within fifteen (15) inches of any tree, it shall be done so by hand trimming only.
7. Meet requirements of ANSI A300 for Definitions, Pruning Tools and Equipment, Pruning Cuts, and Wound Treatment.
8. Perform crown cleaning to eliminate weak branches, water sprouts, dead growth, dying growth, diseased growth, and damaged growth.
9. Perform crown thinning to reduce toppling and wind damage.
10. Perform crown reduction and shaping to maintain growth within space limitations and maintain a natural appearance.
11. Retain lower branches in a "tipped back" or pinched condition to promote caliper trunk growth.
12. Do not cut back to fewer than six buds or leaves on branches.
13. Prune damaged trees or those that constitute health or safety hazards at any time of year.

3.8 WEED REMOVAL

- A. Keep mulched areas between trees and inside protection fencing and watering saucers weed free. Hand weeding weekly is preferred but as a last resort, use least toxic herbicides.
- B. Contractor shall obtain prior approval from the Owner's representative before applying the herbicides.
- C. The Contractor shall be held solely responsible for plant loss due to the application of herbicides. Any loss of plant material shall be replaced at Contractor's sole expense and all plant replacements shall be of the same species and size of the existing plant materials.
- D. Regard all herbicides as hazardous to health and dangerous to the environment; chemicals should be handled with extreme caution and only by experienced personnel. Read and follow all label directions and apply in manner to comply with local, state and federal guidelines. Limit public access to any area recently treated with herbicides.

3.9 INSECT, DISEASE, MITE AND BALL MOSS CONTROL

- A. General: Employ principles of IPM in the selection of preventative and control measures for plant pests and diseases. Insignificant pests will be tolerated providing they do not seriously threaten planting health and appearance. Monitor the site closely and take timely action to address problems identified. Use personnel licensed and experienced using materials approved by the EPA and conform to applicable laws, codes and regulations, under the direction of a licensed certified pest control operator. When necessary apply the least toxic material required for the existing problem. Apply sprays only if a pest or disease is a serious threat and cease application after problem is under control. Spray with extreme care to avoid hazards to any person, pet, or automobile in the area or adjacent areas. Meet requirements of manufacturer's current printed label and application instructions. The Contractor shall be held liable for plant damage due to the use of pesticides.

- B. Plant Condition Inspection: Inspect plant material weekly for damage and signs of insect, disease, mite and ball moss. Submit a written and photographic inspection report of observed damage, and signs of insect, disease, mite and ball moss immediately upon observation via e-mail to the Owner's Designated Representative. Use a digital camera with at least 5.0 megapixels of resolution to document observations.
- C. Spraying: When necessary apply the least toxic material required for the existing problem. Meet requirements of manufacturer's current printed instructions. Apply sprays only as approved in writing by Owner's Designated Representative.
- D. Treatment for Fire Ants: In the tree protection zone, broadcast spread Fipronil, Logic, or Award and spot treat with Orthene granules when present.

3.10 FERTILIZING AND OTHER TREATMENT

- A. Tree Fertilization Program:
 - 1. Fertilize trees on February 1, April 1, June 1, and August 1.
 - 2. Fertilize all trees with a combination of PHC for trees 27-9-9 and Mycor Tree Injectable. Mix 8 pounds of PHC for trees and A and B packets of Mycor Tree Injectable per 100 gallons of water. Apply this solution as a drench at the rate of five gallons per inch trunk diameter measured at breast height over the top of the root ball. Irrigate trees on same day of fertilizer application by operating spray heads or manually watering for 20–30 minutes. Water in short cycles so that run-off does not occur.

3.11 CLEAN-UP

Remove and dispose of protective materials, enclosures and fencing upon completion of the Work.

3.12 FINAL ACCEPTANCE

Receive approval from the Owner's Representative for the work of this section.

END OF SECTION

SECTION 016000

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for following:**

1. **Selection of products.**
2. **Product delivery, storage, and handling.**
3. **Manufacturers' standard warranties.**
4. **Special warranties.**
5. **Comparable products.**

1.3 DEFINITIONS

- A. **Products:** Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 1. **Named Products:** Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 2. **New Products:** Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 3. **Comparable Product:** Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. **Basis-of-Design Product Specification:** A specification in which a specific manufacturer's product is named and accompanied by the words "Basis-of-Design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 SUBMITTALS

- A. **Comparable Product Requests:** Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 1. Refer to Section 012500 - Substitution Procedures.
 2. **Include data to indicate compliance with the requirements specified in "Comparable Products" Article.**
 3. **Architect's Action:** If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Construction Manager of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.
- B. **Basis-of-Design Product Specification Submittal:** Comply with requirements in

Section 013300 - Submittal Procedures. Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Construction Manager is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. **Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.**

B. **Delivery and Handling:**

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. **Storage:**

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Construction Manager of obligations under requirements of the Contract Documents.

1. **Manufacturer's Warranty:** Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner.

- B. **Special Warranties:** Prepare a written document that contains appropriate terms and identification, ready for execution.

1. **Manufacturer's Standard Form:** Modified to include Project-specific information and properly executed.
2. **Specified Form:** When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

- C. **Submittal Time:** Comply with requirements in Section 017700 - Closeout Procedures.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. **General Product Requirements: Provide products that comply with the Contract Documents**, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. **Standard Products:** If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. **Architect reserves the right to limit selection to products with warranties that do not conflict with requirements of the Contract Documents.**
 4. **Where products are accompanied by the term "as selected," Architect will make selection.**
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. **Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.**
- B. **Product Selection Procedures:**
1. **Product:** Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. **Comparable products or substitutions for Construction Manager's convenience will not be considered.**
 2. **Manufacturer/Source:** Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. **Comparable products or substitutions for Construction Manager's convenience will not be considered.**
 3. **Products:**
 - a. **Restricted List:** Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Construction Manager's convenience will not be considered .
 - b. **Non-restricted List:** Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
 4. **Manufacturers:**
 - a. **Restricted List:** Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Construction Manager 's convenience will not be considered .
 - b. **Nonrestricted List:** Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
 5. **Basis-of-Design Product:** Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. **Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.**
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 - Substitution

Procedures for proposal of product.

- D. **Visual Selection Specification:** Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select products that comply with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's full and complete product lines including both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. **Conditions for Consideration:** Architect may consider Construction Manager's request for comparable product when all of the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents, and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. **Comparison of the original and proposed comparable products does not require significant time on the Architect's, or Architect's consultants' part to approve the product.**
 3. **A detailed comparison of the significant qualities of proposed product and those named in the Specifications is provided for the Architect's review. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.**
 4. Evidence that proposed product provides specified warranty.
 5. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, is provided to the Architect.
 6. Samples of the proposed product are provided, if requested.
 7. Provisions under Substitutions Section of the Specifications have been met.

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 017300

EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:** General administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering.
 - 3. Installation of the Work.
 - 4. Cutting and patching.
 - 5. Owner-installed products.
 - 6. Progress cleaning.
 - 7. Starting and adjusting.
 - 8. Protection of installed construction.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 SUBMITTALS

- A. **Certificates:** Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.
- B. **Certified Surveys:** Submit two compact disks of drawings in PDF electronic file format.

1.5 QUALITY ASSURANCE

- A. **Land Surveyor Qualifications:** A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. **Cutting and Patching:** Comply with requirements for and limitations on cutting and patching of construction elements.
 - 1. **Structural Elements:** When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
 - 2. **Operational Elements:** Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include but are not limited to the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Mechanical systems piping and ducts.
 - f. Control systems.

- g. Communication systems.
- h. Fire-detection and -alarm systems.
- i. Conveying systems.
- j. Electrical wiring systems.
- k. Operating systems of special construction.
- 3. **Other Construction Elements:** Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior wall construction.
 - d. Sprayed fire-resistive material.
 - e. Equipment supports.
 - f. Piping, ductwork, vessels, and equipment.
 - g. Noise- and vibration-control elements and systems.
 - h. Structural elements.
- 4. **Visual Elements:** Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
- C. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Existing Conditions:** The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
 - 1. **Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.**
 - 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. **Examination and Acceptance of Conditions:** Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.

2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. **Written Report:** Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
1. Description of the Work.
 2. List of detrimental conditions, including substrates.
 3. List of unacceptable installation tolerances.
 4. Recommended corrections.
- D. **Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.**

3.2 PREPARATION

- A. **Existing Utility Information:** Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. **Field Measurements:** Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. **Space Requirements:** Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. **Review of Contract Documents and Field Conditions:** Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Construction Manager, submit a request for information (RFI) to Architect according to requirements in Section 013100 - Project Management and Coordination.

3.3 CONSTRUCTION LAYOUT

- A. **Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks.** If discrepancies are discovered, notify Architect promptly.
- B. **General: Engage a land surveyor to lay out the Work using accepted surveying practices.**
1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 2. Establish limits on use of Project site.
 3. Establish dimensions within tolerances indicated. **Do not scale Drawings to obtain required dimensions.**
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major element as the Work progresses.
 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. **Site Improvements:** Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. **Building Lines and Levels:** Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. **Record Log:** Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. **Reference Points:** Locate a minimum of two existing permanent benchmarks, control points, and similar reference points in relation to USGS GIS waypoints before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- B. **Benchmarks:** Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- C. **Certified Survey:** On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

3.5 INSTALLATION OF THE WORK

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. **Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.**
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. **Blocking and Attachment:** Provide blocking as required and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work **whether or not shown on the drawings**. Where size and type of attachments are not indicated, verify size and type required for load conditions.
 - 1. **Mounting Heights:** Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for building movement, including thermal expansion and contraction.
 - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to

Project site in time for installation.

- I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

- A. **Cutting and Patching, General:** Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
 - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. **Existing Warranties:** Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
- C. **Temporary Support:** Provide temporary support of work to be cut.
- D. **Protection:** Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- E. **Adjacent Occupied Areas:** Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 - Summary.
- F. **Existing Utility Services and Mechanical/Electrical Systems:** Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
- G. **Cutting:** Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 - 4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
 - 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 6. Proceed with patching after construction operations requiring cutting are complete.
- H. **Patching:** Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.
 - 1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
 - 2. **Exposed Finishes:** Restore exposed finishes of patched areas and extend finish restoration to finished edges of wall, ceiling or object being patched in a manner that will minimize evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 3. **Floors and Walls:** Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even

surface of uniform finish, color, texture, and appearance to edges of walls or ceilings. Remove in-place floor and wall coverings and replace with new materials to edges of walls and floors to achieve uniform color and appearance.

- a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire surface to the nearest adjacent surface edges or corners. Provide additional coats until patch blends with adjacent surfaces.
4. **Ceilings:** Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance. At painted surfaces, paint entire surface to nearest adjacent ceiling termination or edge
5. **Exterior Building Enclosure:** Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
- I. **Cleaning:** Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.
 1. Construction Schedule: Inform Owner of Construction Manager's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
- B. **Site:**
 1. **Maintain Project site free of waste materials and debris.**
 2. **Maintain positive drainage and slope away from building slab.**
- C. **Work Areas:** Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. **Installed Work:** Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. **Concealed Spaces: Remove debris from concealed spaces before enclosing the space.**
- F. **Exposed Surfaces in Finished Areas:** Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. **Waste Disposal:** Do not bury or burn waste materials on-site. Do not wash waste materials

- down sewers or into waterways.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
 - I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
 - J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- 3.9 **STARTING AND ADJUSTING**
- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
 - B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
 - C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - D. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 - Quality Requirements.
- 3.10 **PROTECTION OF INSTALLED CONSTRUCTION**
- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
 - B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

SECTION 017700

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for contract closeout, including, but not limited to, the following:**
 - 1. **Substantial Completion procedures.**
 - 2. **Final completion procedures.**
 - 3. **Warranties.**
 - 4. **Final cleaning.**
 - 5. **Repair of the Work.**

1.3 SUBMITTALS

- A. Construction Manager's List of Incomplete Items: Initial submittal at Substantial Completion.
- B. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 SUBSTANTIAL COMPLETION PROCEDURES

- A. **Construction Manager's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Construction Manager's punch list).**
- B. **Submittals Prior to Substantial Completion:** Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. **Include certificates of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.**
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number where applicable.
 - 5. Submit test/adjust/balance records.
 - 6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. **Procedures Prior to Substantial Completion:** Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 - 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in

Section 017900 - Demonstration and Training.

6. Advise Owner of changeover in heat and other utilities.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements, including touchup painting.
10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. **Inspection:** Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Construction Manager of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Construction Manager of items, either on Construction Manager's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

1.5 FINAL COMPLETION PROCEDURES

A. **Submittals Prior to Final Completion:** Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 012900 - Payment Procedures.
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.

B. **Inspection:** Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Construction Manager of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Construction Manager of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. **Organization of List:** Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Construction Manager that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Page number.

4. Submit list of incomplete items in the following format:
 - a. MS Excel electronic file. Architect will return annotated file.

1.7 REINSPECTION FEES

- A. **Should status of completion of Work require reinspection by Architect due to failure of Work to comply with Construction Manager's claims on initial inspection, Owner will deduct the amount of Architect's and appropriate consultants' compensation and reimbursable expenses for reinspection services from final payment to Construction Manager.**

1.8 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Construction Manager.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Construction Manager.
 4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. **Cleaning: Employ experienced workers or professional cleaners for final cleaning.** Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

- b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - g. Sweep concrete floors broom clean in unoccupied spaces.
 - h. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 - i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - j. Remove labels that are not permanent.
 - k. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint droppings, and other foreign substances.
 - l. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - m. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - n. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 - o. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
 - p. Leave Project clean and ready for occupancy.
- C. Pest Control: Comply with pest control requirements in Section 015000 - Temporary Facilities and Controls. Prepare written report.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. **Repair or remove and replace defective construction.** Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
 - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION

SECTION 017823

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for preparing operation and maintenance manuals, including the following:**
 - 1. **Operation and maintenance documentation directory.**
 - 2. **Emergency manuals.**
 - 3. **Operation manuals for systems, subsystems, and equipment.**
 - 4. **Product maintenance manuals.**
 - 5. **Systems and equipment maintenance manuals.**

1.3 SUBMITTALS

- A. **Manual Content:** Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. **Format: Submit operations and maintenance manuals in the following format:**
 - 1. **PDF Electronic Files.**
 - 2. **Paper copies.**
- C. **Initial Manual Submittal:** Submit PDF electronic files of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable and return one copy.
- D. **Final Manual Submittal:** Submit PDF electronic files of each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return one copy with comments.
 - 1. Correct or revise each manual to comply with Architect's comments. Submit PDF electronic files and paper copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. **Directory:** Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:
 - 1. List of documents.
 - 2. List of systems.
 - 3. List of equipment.
 - 4. Table of contents.
- B. **List of Systems and Subsystems:** List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. **List of Equipment:** List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

- D. **Tables of Contents:** Include a table of contents for each emergency, operation, and maintenance manual.
- E. **Identification:** In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. **Organization:** Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. **Title Page:** Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Construction Manager.
 - 6. Name and contact information for Architect.
 - 7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 - 8. Cross-reference to related systems in other operation and maintenance manuals.
- C. **Table of Contents:** List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. **Manual Contents:** Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. **Manuals, Electronic Files:** Assemble manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. **Electronic Files:** Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. **File Names and Bookmarks:** Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

2.3 EMERGENCY MANUALS

- A. **Content:** Organize manual into a separate section for each of the following:
 - 1. Type of emergency.
 - 2. Emergency instructions.
 - 3. Emergency procedures.
- B. **Type of Emergency:** Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - 1. Fire.

2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- C. **Emergency Instructions:** Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. **Emergency Procedures:** Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

2.4 OPERATION MANUALS

- A. **Content:** In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Construction Manager has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- B. **Descriptions:** Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- C. **Operating Procedures:** Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
- D. **Systems and Equipment Controls:** Describe the sequence of operation, and diagram controls as installed.

- E. **Piped Systems:** Diagram piping as installed, and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE MANUALS

- A. **Content:** Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. **Source Information:** List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. **Product Information:** Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- D. **Maintenance Procedures:** Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- E. **Repair Materials and Sources:** Include lists of materials and local sources of materials and related services.
- F. **Warranties and Bonds:** Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. **Content:** For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. **Source Information:** List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- C. **Manufacturers' Maintenance Documentation:** Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. **Maintenance Procedures:** Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.

- E. **Maintenance and Service Schedules:** Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. **Spare Parts List and Source Information:** Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. **Maintenance Service Contracts:** Include copies of maintenance agreements with name and telephone number of service agent.
- H. **Warranties and Bonds:** Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. **Operation and Maintenance Documentation Directory:** Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. **Emergency Manual:** Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. **Product Maintenance Manual:** Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. **Operation and Maintenance Manuals:** Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- E. **Manufacturers' Data:** Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. **Drawings:** Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of operation and maintenance manuals.
- G. Comply with Section 017700 - Closeout Procedures for schedule for submitting operation and maintenance documentation.

END OF SECTION

SECTION 017839

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for project record documents, including the following:**
 - 1. **Record Drawings.**
 - 2. **Record Specifications.**
 - 3. **Record Product Data.**
 - 4. **Miscellaneous record submittals.**

1.3 SUBMITTALS

- A. **Record Drawings:** Comply with the following:
 - 1. **Initial Submittal:**
 - a. Submit PDF electronic files of scanned original marked-up record prints.
 - b. Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - 2. **Final Submittal:**
 - a. **Submit PDF electronic files of scanned record prints.** Print each drawing, whether or not changes and additional information were recorded.
 - b. **Submit original marked-up record prints.**
- B. **Record Specifications:** Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. **Record Product Data:** Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. **Miscellaneous Record Submittals:** See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. **Record Prints:** Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. **Preparation: Mark record prints to show the actual installation where installation varies from that shown originally.** Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding archive photographic documentation.
 - 2. **Content:** Types of items requiring marking include, but are not limited to, the following:

- a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
3. **Mark the Contract Drawings and Shop Drawings completely and accurately.** Use personnel proficient at recording graphic information in production of marked-up record prints.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. **Mark important additional information that was either shown schematically or omitted from original Drawings.**
 6. Note the following, along with the sequence numbers:
 - a. Requests for information.
 - b. Architect's Supplemental Instructions.
 - c. Construction Change Directives.
 - d. Alternates.
 - e. Change Orders.
- B. **Record Digital Data Files:** Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 4. Refer instances of uncertainty to Architect for resolution.
 5. Architect will furnish Construction Manager one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013300 - Submittal Procedures for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. **Format:** Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Construction Manager.

2.2 RECORD SPECIFICATIONS

- A. **Preparation:** Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 - 5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. **Format:** Submit record Specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

- A. **Preparation:** Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. **Format:** Submit record Product Data as annotated PDF electronic file.
 - 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. **Format:** Submit miscellaneous record submittals as PDF electronic file.
 - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. **Recording:** Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. **Maintenance of Record Documents and Samples:** Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION

SECTION 017900

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes: Administrative and procedural requirements for instructing Owner's personnel, including the following:**
 - 1. **Demonstration of operation of systems, subsystems, and equipment.**
 - 2. **Training in operation and maintenance of systems, subsystems, and equipment.**
 - 3. **Demonstration and training video recordings.**

1.3 SUBMITTALS

- A. **Instruction Program:** Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. **Attendance Record:** For each training module, submit list of participants and length of instruction time.
- C. **Demonstration and Training Video Recordings: Submit electronic files within seven days of end of each training module.**
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Construction Manager.
 - e. Date of video recording.
 - 2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
 - 3. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format.

1.4 QUALITY ASSURANCE

- A. **Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 - Quality Requirements, experienced in operation and maintenance procedures and training.**
- B. **Preinstruction Conference:** Conduct conference at Project site to comply with requirements in Section 013100 - Project Management and Coordination. Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather

conditions and procedures to follow if conditions are unfavorable.

1.5 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. **Program Structure:** Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. **Training Modules:** Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. **Basis of System Design, Operational Requirements, and Criteria:** Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Operating standards.
 - c. Regulatory requirements.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - 2. **Documentation:** Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Maintenance service agreements and similar continuing commitments.
 - 3. **Emergencies:** Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. **Operations:** Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.

- m. Special operating instructions and procedures.
- 5. **Adjustments:** Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
- 6. **Troubleshooting:** Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
- 7. **Maintenance:** Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
- 8. **Repairs:** Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 - Operation and Maintenance Data.

3.2 INSTRUCTION

- A. **Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Construction Manager and Owner for number of participants, instruction times, and location.**
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner with at least seven days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Suspended slabs.
 - 2. Building frame members.
 - 3. Building walls.
 - 4. Drilled Piers
- B. WORK INCLUDED
 - 1. Design, fabrication, erection, and stripping of formwork for cast-in-place concrete including shoring, reshoring, falsework, bracing, proprietary forming systems, prefabricated forms, void forms, permanent metal forms, bulkheads, keys, blockouts, sleeves, pockets, and accessories. Erection shall include installation in formwork of items furnished by other trades.
 - 2. Furnish all labor and materials required to fabricate, deliver and install reinforcement and embedded metal assemblies for cast-in-place concrete, including steel bars, welded steel wire fabric, ties and supports.
 - 3. Furnish all labor and materials required to perform the following:
 - a. Cast-in-place concrete
 - b. Concrete mix designs
 - c. Grouting structural steel baseplates
 - d. Concrete for drilled piers
- C. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Architectural Concrete" for general building applications of specially finished formed concrete.
 - 2. Division 31 Section "Drilled Piers" for drilled concrete piers.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture submit proposed mix designs in accordance with ACI 318, chapter 5. Each proposed mix design shall be accompanied by a record of past performance.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 - 1. Do not reproduce the structural drawings for use as shop drawings.
 - 2. Embedded metal assemblies: Submit shop drawings for fabrication and placement. Use standard AWS welding symbols.
- D. Steel Reinforcement Submittals for Information: Mill test certificates of supplied concrete reinforcing, indicating physical and chemical analysis.
- E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates.
- F. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials
 - 2. Admixtures
 - 3. Moisture Vapor Reduction Admixture
 - 4. Form materials and form-release agents
 - 5. Steel reinforcement and accessories
 - 6. Fiber reinforcement
 - 7. Waterstops
 - 8. Curing compounds
 - 9. Floor and slab treatments
 - 10. Vapor retarders
 - 11. Repair materials
- G. Submit manufacturer's certification of maximum chloride ion content in admixtures.
- H. Fly ash: Submit certification attesting to carbon content and compliance with ASTM C618.
- I. Construction Joint Layout: Submit a diagram of proposed construction joint locations for horizontal framing that exceed the limits of a single placement as stated in the structural notes, other than those indicated on the Drawings.
- J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.
- K. Field quality-control test and inspection reports.

- L. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Owner may engage a qualified independent testing agency to perform material evaluation tests.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- C. Store all proprietary materials in accordance with manufacturer's recommendations.

1.7 WARRANTY

- A. Moisture Vapor Reduction Admixture (MVRA)

1. Manufacturer's Warranty: Manufacturer's standard form warranty document executed by an authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights the Owner may have under provisions of the Contract Documents.
 - a. Warranty Period: 10 years from date of Substantial Completion.
 - b. Warranty covers performance of concrete water vapor reducing admixture as well as labor and material for flooring replacement in accordance with manufacturer's current standards and applicable test results performed in accordance with ASTM D5084.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
 3. Steel Forms
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
 1. Pans shall be free of dents, irregularities, sag, or other deterioration.
- E. Void Forms: Shall be the product of a reputable manufacturer regularly engaged in the commercial production of void forms.
 1. Void form composition shall be of corrugated paper material with a moisture resistant exterior and an interior fabrication of a uniform cellular configuration, composed of components constructed of double-faced wax-impregnated (partially or fully), corrugated fiberboard that is laminated with moisture resistant adhesive.
 2. Design and maintain void forms to support all vertical and lateral loads that might be applied during construction until such loads can be supported by the concrete structure.
 3. Form material shall be designed to lose its strength under prolonged contact with the moisture which normally accumulates beneath slabs and beams on grade.
 4. Void forms shall be used around the circular edges of all drilled piers at the intersection of the gradebeams and/or structural slabs by using premanufactured, non-field cut, sealed void forms with curved edges adjacent to drilled piers.

5. Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, VoidForm Products, Inc., Englewood, Colorado.
- F. Protection Board: For use over void forms under structural slabs. Hard-pressed cellulose fiber board, 1/4 inch minimum thickness.
- G. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- H. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- I. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- J. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
- K. Form Ties for Exposed Finishes: Water seal coil type internally disconnecting ties with tapered plastic cone spreader designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal. Plugs to fill tie cone to be in plastic or mortar to match surrounding concrete. Plugs to be recessed 1/4 inch from surface of finished concrete.
 1. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
- L. Soil Retainers: Shall be provided where specified and shown on the drawings to prevent migration of backfill under suspended foundation elements:
 1. Retainers shall be composed of high density polypropylene materials that are not adversely affected by moisture. They must be flexible, impact resistant and have sufficient strength to resist lateral loads applied by soil.
 - a. Thickness: 3/8" for void spaces of 8" or less.
 - b. Soil retainers shall extend six inches above the void forms and a minimum of 3 inches below the void forms.
 2. Retainers shall be ribbed and made from high density polyethylene. Refer to the Drawings for additional information. Soil retainers shall be Motzblock by VoidForm Products, Inc.

2.2 STEEL REINFORCEMENT

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

- D. Plain-Steel Wire: ASTM A 82, as drawn.
- E. Deformed-Steel Wire: ASTM A 496.
- F. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For slabs on grade and slabs on void forms, provide sand plates, horizontal runners, or precast concrete blocks on bottom where base material will not support chair legs or where vapor barrier has been specified.

2.4 MECHANICAL SPLICES

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Provide mechanical splices designed to develop, in tension and compression, 125 percent of the minimum ASTM specified yield strength of the smaller bar being spliced. The following splicing systems are acceptable:
 - 1. Erico "Cadweld T-Series"
 - 2. Erico "Lenton"
 - 3. Dayton Barsplice "Bar-Grip"
 - 4. Dayton Barsplice "Grip-Twist"

2.5 DOWEL BAR ANCHORS

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Provide dowel bar anchors and threaded dowels designed to develop, in tension and compression, 125 percent of the minimum ASTM specified yield strength of the dowel bars. Unless otherwise indicated, anchors shall be furnished with ACI standard 90 degree hooks. Dowels shall be furnished by the anchor supplier. The following dowel splicing systems are acceptable:

1. Richmond Screw Anchor "Dowel Bar Splicer"
2. Erico "Lenton Form Saver"
3. Dayton Barsplice "Grip-Twist"

2.6 EMBEDDED METAL ASSEMBLIES

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Steel Shapes and Plates: ASTM A36
- C. Headed Studs: Heads welded by full-fusion process, as furnished by TRW Nelson Stud Welding Division.
- D. Welded Deformed Bar Anchors: Welded by full fusion process, as furnished by TRW Nelson Stud Welding Division.
- E. Reinforcing Bars to be Welded: ASTM A706.

2.7 INSERTS

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Provide metal inserts required for anchorage of materials or equipment to concrete construction where not supplied by other trades:
 1. In vertical concrete surfaces for transfer of direct shear loads only, provide adjustable inserts, complete with bolts, nuts, and washers. Provide 3/4" bolt size unless otherwise indicated. Adjustable inserts shall be one of the following:
 - a. Malleable iron wedge inserts:
 - 1) Hohmann & Barnard, Inc.: #HW-340 and LW-340
 - 2) Heckmann Building Products, Inc.: #425-6 and 425-6L
 - 3) Peerless Hardware, Inc.: #250-3/4 and 250-3/4L
 - b. Hohmann & Barnard, Inc. Sharktooth inserts ST-3 or ST-4 (hot-dip galvanized finish).
 - c. Provide the long versions of the inserts at beam and slab soffit conditions, unless noted otherwise.
 2. In horizontal concrete surfaces and whenever inserts are subject to tension forces, provide threaded inserts of malleable cast iron, furnished with full depth bolts, 3/4" bolt size unless otherwise indicated.

2.8 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 1. Portland Cement: ASTM C 150, Type I/II, gray.
 - a. Fly Ash: ASTM C 618, Class F.

- B. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: As indicated on drawings.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.9 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- C. Moisture Vapor Reduction Admixture: For use in all interior slabs, slabs on deck, and roof decks.
 - 1. Basis-of-Design Product: The concrete water vapor reducing admixture is based on Vapor Lock 20/20 manufactured by Specialty Products Group (SPG), or comparable product by one of the following:
 - a. Barrier One by Barrier One, Incorporated.
 - b. Xypex by Xypex Chemical Corporation.
 - c. Aridus SDA 30 by USC Technologies.
 - d. MVRA 900 by ISE Logik Industries.
 - 2. Concrete Water Vapor Reducing Admixture (WVRA): A complex admixture for cementitious materials, free of volatile organic compounds (VOC), designed to naturally chemically react with pre-existing elements within the cementitious material to eliminate the route of moisture vapor emission by integrally and permanently closing the capillary system in the concrete with the following characteristics:
 - a. Waterproofing: Minimum 1×10^{-8} cm/s in accordance with ASTM D5084.
 - b. Toxicity: None.
 - c. Flammability: None.
 - d. Solvent: Water.
 - e. Acid Resistance: Excellent.
 - f. Hazardous Vapors: None.
 - g. Capillary Break: Calcium Silicate Hydrate.
 - h. Installation: All cementitious materials.
 - i. VOC Levels: Zero (0).
 - j. Inhibit mold and bacteria growth by eliminating moisture vapor emission.

2.10 WATERSTOPS

- A. Waterstops: At all construction joints below grade. "Synko-Flex" Preformed Plastic Waterstop by the Henry Company, Inc., meeting the requirements of Federal Specification SSS-210.

2.11 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E 1745, Class A.

1. Membrane shall have the following properties:

- a. Minimum 15 mils thickness.
- b. Permeance Rating: ASTM E96, 0.01 Perms or lower as tested after mandatory conditioning (ASTM E 154 sections 8, 11, 12, 13)
- c. Installation shall be in accordance with ASTM E1643 and manufacturer's instructions.

2. Products:

- a. Carlisle Coatings & Waterproofing, Inc.: Blackline 400.
- b. Epro; Ecoshield-E 15 mil.
- c. Inteplast Group; Barrier Bac VBC-350 Composite Vapor Retarder
- d. Reef Industries; Vaporguard.
- e. Stego Wrap 15 mil, by Stego.
- f. W.R. Meadows, Inc.: Premolded Membrane with Plasmatic Core (PMPC).

3. Accessories

- a. Perimeter/seam sealing tape for use with membranes that are not self-adhering to the underside of concrete slabs on void forms:
 - 1) Crete Claw detail tape by Stego Industries, LLC, for adhering vapor retarder membrane to the underside of concrete surface at slabs on carton void forms, 3-inch and 6-inch widths as noted in Part 3.
 - 2) StegoTack double-sided adhesive tape by Stego Industries, LLC, for adhering membrane to concrete at gradebeams.
- b. Manufacturer's recommended standard adhesive or pressure sensitive tape for general use.

2.12 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products:

- a. Axim Concrete Technologies; CATEXOL Cimfilm.
- b. BASF Construction Chemicals – Building Systems; Confilm.
- c. ChemMasters; Spray-Film.
- d. Conspec by Dayton Superior; Aquafilm.
- e. Dayton Superior Corporation; Sure Film (J-74).
- f. Edoco by Dayton Superior; BurkeFilm.
- g. Euclid Chemical Company (The), an RPM company; Eucobar.

- h. Kaufman Products, Inc.; Vapor Aid.
 - i. Lambert Corporation; LAMBCO Skin.
 - j. L&M Construction Chemicals, Inc.; E-Con.
 - k. Meadows, W. R., Inc.; EVAPRE.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. SpecChem, LLC; Spec Film.
 - p. Symons by Dayton Superior; Finishing Aid.
 - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
 - r. Unitex; Pro-Film.
 - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. Products:
- a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. BASF Construction Chemicals – Building Systems; Kure 200.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec by Dayton Superior; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - f. Edoco by Dayton Superior; Res X Cure WB.
 - g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
 - h. Kaufman Products, Inc.; Thinfilm 420.
 - i. Lambert Corporation; Aqua Kure-Clear.
 - j. L&M Construction Chemicals, Inc.; L&M Cure R.
 - k. Meadows, W. R., Inc.; 1100 Clear.
 - l. Nox-Crete Products Group; Resin Cure E.
 - m. Right Pointe; Clear Water Resin.
 - n. SpecChem, LLC; Spec Rez Clear.
 - o. Symons by Dayton Superior; Resi-Chem Clear.
 - p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
 - q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.13 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Reglets: Fabricate reglets of not less than 0.0217-inch-thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

- D. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- E. Adjustable wedge inserts: For attachment of masonry shelf angles to spandrel beams. Provide Hohmann & Barnard wedge inserts by Hohmann & Barnard, Inc., or approved equal. Type, size and capacity shall be as shown on the Drawings.
- F. Sleeves and Blockouts: Formed with galvanized metal, galvanized pipe, polyvinyl chloride pipe, fiber tubes, or wood.
- G. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required; of strength and character to maintain formwork in place while placing concrete.

2.14 REPAIR MATERIALS

- A. Repair Mortar – Hand-Applied: Pre-packaged, cement-based, two-component, polymer-modified, trowel-grade mortar, enhanced with penetrating corrosion inhibitor.
 - 1. Compressive Strength: 1200 psi minimum at 1 day; 6000 psi minimum at 28 days when tested according to ASTM C 109.
 - 2. Bond Strength: 1800 psi minimum at 28 days when tested according to ASTM C 882 (Modified).
 - 3. Product / Manufacturer: SikaTop 122 Plus or SikaTop 123 Plus, Sika Corporation, or approved equal.
- B. Repair Mortar – Form and Pour or Pump: Pre-packaged, cement-based, single-component, polymer-modified, silica-fume-enhanced, cementitious mortar.
 - 1. Compressive Strength: 3000 psi minimum at 1 day; 6500 psi at 28 days when tested according to ASTM C 109.
 - 2. Bond Strength: 2200 psi at 28 days when tested according to ASTM C 882 (modified).
 - 3. Product / Manufacturer: Sika MonoTop 611, Sika Corporation, or approved equal.

2.15 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
 - 2. Required average strength above specified strength:
 - a. Based on a record of past performance: Determination of required average strength above specified strength shall be based on the standard deviation record of the results of at least 30 consecutive strength tests in accordance with ACI 318, Chapter 5.3 by the larger amount defined by formulas 5-1 and 5-2.
 - b. Based on laboratory trial mixtures: Proportions shall be selected on the basis of laboratory trial batches prepared in accordance with ACI 318, Chapter 5.3.3.2 to produce an average strength greater than the specified strength f'_c by the amount defined in table 5.3.2.2.

- 1) Proportions of ingredients for concrete mixes shall be determined by an independent testing laboratory or qualified concrete supplier.
 - 2) For each proposed mixture, at least three compressive test cylinders shall be made and tested for strength at the specified age. Additional cylinders may be made for testing for information at earlier ages.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Do not use admixtures which have not been incorporated and tested in accepted mixes.
 2. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 3. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 4. Use water-reducing admixture in pumped concrete and concrete with a water-cementitious materials ratio below 0.50.

2.16 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Proportion normal-weight concrete mixture as indicated on drawings.

2.17 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.18 FABRICATION OF EMBEDDED METAL ASSEMBLIES

- A. Fabricate metal assemblies in the shop. Holes shall be made by drilling or punching. Holes shall not be made by or enlarged by burning. Welding shall be in accordance with AWS D1.1.
- B. Welding of deformed bar anchors and headed stud anchors shall be done by full fusion process equal to that of TRW Nelson Stud Welding Division. A minimum of two headed studs shall be tested at the start of each production period for proper quality control. The studs shall be capable of being bent 45 degrees without failure.
- C. Welding of reinforcement shall be done in accordance with AWS D1.4, using the recommended preheat temperature and electrode for the type of reinforcement being welded. Bars larger than no. 9 shall not be welded. Welding shall be subject to the observance and testing of the Testing Laboratory.

- D. Metal assemblies exposed to earth, weather or moisture shall be hot dip galvanized. All other metal assemblies shall be either hot dip galvanized or painted with an epoxy paint. Repair galvanizing after welding with a Cold Galvanizing compound installed in accordance with the manufacturer's instructions. Repair painted assemblies after welding with same type of paint.

2.19 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. **Maximum delivery time from batch plant to placement is 90 minutes.**
 - 2. When air temperature is between 85 and 95 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 95 deg F, reduce mixing and delivery time to 60 minutes.
 - 3. **Maximum allowable concrete temperature at delivery is 90 degrees.**

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
 - 1. Vertical alignment:
 - a. Lines, surfaces and arises less than 100 feet in height - 1 inch.
 - b. Outside corner of exposed corner columns and control joints in concrete exposed to view less than 100 feet in height - 1/2 inch.
 - 2. Lateral alignment:
 - a. Members - 1 inch.
 - b. Centerline of openings 12 inches or smaller and edge location of larger openings in slabs - 1/2 inch.
 - c. Sawcuts, joints, and weakened plane embedments in slabs - 3/4 inch.
 - 3. Level alignment:
 - a. Elevation of slabs-on-grade - 3/4 inch.
 - b. Elevation of top surfaces of formed slabs before removal of shores - 3/4 inch.
 - c. Elevation of formed surfaces before removal of shores - 3/4 inch.
 - d. Lintels, sills, parapets, horizontal grooves, and other lines exposed to view - 1/2 inch.
 - 4. Cross-sectional dimensions: Overall dimensions of beams, joists, and columns and thickness of walls and slabs.

- a. 12 inch dimension or less - plus 3/8 inch to minus 1/4 inch.
 - b. Greater than 12 inch to 3 foot dimension - plus 1/2 inch to minus 3/8 inch.
 - c. Greater than 3 foot dimension - plus 1 inch to minus 3/4 inch.
- 5. Relative alignment:
 - a. Stairs:
 - 1) Difference in height between adjacent risers - 1/8 inch.
 - 2) Difference in width between adjacent treads - 1/4 inch.
 - 3) Maximum difference in height between risers in a flight of stairs - 3/8 inch.
 - 4) Maximum difference in width between treads in a flight of stairs - 3/8 inch.
 - b. Grooves:
 - 1) Specified width 2 inches or less - 1/8 inch.
 - 2) Specified width between 2 inches and 12 inches - 1/4 inch.
 - c. Vertical alignment of outside corner of exposed corner columns and control joint grooves in concrete exposed to view - 1/4 inch in 10 feet.
 - d. All other conditions - 3/8 inch in 10 feet.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class C, 1/2 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Construct formwork to cambers shown or specified on the Drawings to allow for structural deflection of the hardened concrete. Provide additional elevation or camber in formwork as required for anticipated formwork deflections due to weight and pressures of concrete and construction loads.
- H. Forms for Exposed Concrete:
 - 1. Drill forms from the contact face to the outside to suit form ties used. Do not splinter forms by driving ties through improperly prepared holes.
 - 2. Provide sharp, clean corners at intersecting planes without visible edges or offsets. Back joints with extra studs or girts if required to maintain corners.
 - 3. Provide extra studs, girts, walers, and bracing to prevent bowing of forms.
 - 4. Form shapes, recesses and projections with smooth finish materials, and install in forms with sealed joints.

5. Locate form ties in level horizontal rows, plumbed vertically, and in symmetrical arrangements, unless noted otherwise.
- I. Foundation Elements: The sides of all below grade portions of beams, pier caps, walls, and columns shall be formed straight and to the lines and grades specified. Foundation elements shall not be earth formed unless specifically indicated on the Drawings.
- J. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- K. Chamfer exterior corners and edges of permanently exposed concrete.
- L. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- M. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- N. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- O. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement, anchoring devices, and embedded items.
 1. Do not apply form release agent where concrete surfaces are scheduled to receive subsequent finishes which may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - a. Spacing within a bolt group: 1/8"
 - b. Location of bolt group (center): 1/2"
 - c. Rotation of bolt group: 5 degrees
 - d. Angle off vertical: 5 degrees
 - e. Bolt projection: $\pm 3/8$ "
 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 3. Install dovetail anchor slots in concrete structures as indicated.

3.3 VOID FORMS

- A. Install void forms in all locations shown on the Drawings. In general, void forms shall be placed below all structural elements supported by piers to separate these elements from the earth.
- B. Seal discontinuous ends of void forms and tape all joints with waterproof tape so that concrete will not enter the void space during placement of concrete. Do not leave gaps between void form sections.
- C. Premanufactured void forms with circular edges shall be used around all drilled piers. Field fabrication of pier void forms is not permitted.
- D. Do not allow any portion of void forms to fall within the circumference of piers causing a reduction in the bearing area.
- E. Protect void forms from water. Do not install void forms during wet weather or on wet ground. Void forms which become saturated prior to placement of concrete shall be removed and replaced. Void forms shall not be wrapped in plastic, or other similar material to protect from moisture when installed.
- F. Exercise care in placement of concrete to avoid collapse of void form. If void forms collapse, soil beneath the concrete shall be dug out and a proper void space shall be created by installing soil retainers on each side of element.
- G. Void forms under slabs shall be protected by a layer of one-quarter inch thick protection board followed by a vapor barrier or retarder per the specifications. Do not install void forms under soil supported slabs on grade.

3.4 SOIL RETAINERS

- A. Install soil retainers in straight, clean trenches at sides of void forms prior to concrete placement. The gaps between the trench and retainers must be properly positioned or backfilled prior to the placement of concrete. Do not cast the sides of concrete beams directly against the soil.
- B. Affix the soil retainers to the concrete beam with adhesive, pin/washer/load, or concrete hard nails spaced on 24 inch centers.

3.5 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Minimum cumulative curing times may be reduced by the use of high-early strength cement or forming systems which allow form removal without disturbing shores, but only after the Contractor has demonstrated to the satisfaction of the Architect that the early removal of forms will not cause excessive sag, distortion or damage to the concrete elements.
 - 3. Wood forms shall be completely removed. Provide temporary openings if required.

4. Provide adequate methods of curing and thermal protection of exposed concrete if forms are removed prior to completion of specified curing time.
 5. Areas required to support construction loads in excess of 20 psf shall be reshored to properly distribute construction loading. Construction loads up to the rated live load capacity may be placed on unshored construction provided the concrete has attained the specified 28-day compressive strength.
 6. Obtaining concrete compressive strength tests for the purposes of form removal shall be the responsibility of the Contractor.
 7. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.6 SHORES AND RESHORES

- A. The Contractor shall be solely responsible for proper shoring and reshoring.
- B. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- C. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
1. All structural framing required to support one or more subsequent levels of construction shall be reshored. Reshores shall be located in the same position on each floor. No construction loads shall be placed on the new construction until all supporting reshores have been installed.
 2. Extend shores or reshored from ground to top level in structure three stories or less in height, unless noted otherwise.
 3. In structures over three stories in height, extend reshores at least three levels under the level being placed. Extend shores beyond the minimum number of levels if required to ensure proper distribution of loads throughout the structure.
 4. In crawl spaces or basements, shores or reshores shall extend to mud pads seated firmly on the soil or to on-grade construction.
 5. Bottom tier of reshores shall remain in place until the supported concrete (at the uppermost level) has attained at least 85 percent of the specified 28 day compressive strength and construction loads in excess of 20 psf have been removed.
 6. Conventionally reinforced uppermost floors do not need to be reshored provided forms supporting concrete are not removed until concrete has attained 85 percent of its specified 28 day compressive strength as established by tests of field cured cylinders.
 7. All levels of reshores may be removed after formwork for the uppermost floor has been removed in accordance with these specifications.

- D. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.7 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
- B. Lap joints 6 inches (150 mm) and seal with tape as noted below.
 - 1. Vapor retarder membrane seal at slabs on void forms for use with membranes that are not self-adhering to the underside of concrete slabs: Seal vapor retarder membrane to underside of slab using perimeter/seam seal tape applied continuously to perimeter of vapor retarder membrane at grade beams (3in. tape) and at the seams at interior conditions (6in. tape).
 - a. Apply double-sided adhesive tape top surface of gradebeam and adhere membrane to tape. Refer to the drawings for detail.
 - b. Remove any dirt or debris from membrane prior to application of sealing tape.
 - 2. General sealing and at slabs on grade: Use manufacturer's standard adhesive or pressure sensitive tape for sealing membrane at seams, pipe penetrations, tears, etc.

3.8 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4, where indicated. Only steel conforming to ASTM A706 may be welded.
- D. Installation tolerances:
 - 1. Top and bottom bars in slabs, girders, beams and joists:
 - a. Members 8" deep or less: $\pm 3/8"$
 - b. Members more than 8" deep: $\pm 1/2"$
 - 2. Concrete Cover to Formed or Finished Surfaces: $\pm 3/8"$ for members 8" deep or less; $\pm 1/2"$ for members over 8" deep, except that tolerance for cover shall not exceed 1/3 of the specified cover.

- E. Concrete Cover: Refer to the Structural Notes.
- F. Splices: Provide standard reinforcement splices by lapping and tying ends. Comply with ACI 318 for minimum lap of spliced bars where not specified on the documents. No. 14 and 18 bars shall not be lap spliced.
- G. Mechanical Splices: Use for splicing of bars larger than no. 11 or where no. 11 bars are spliced to larger size bars and where indicated on the drawings. Comply with manufacturer's instructions for preparation of bars and installation procedures.
- H. Field Welding of Embedded Metal Assemblies: All paint and galvanizing shall be removed in areas to receive field welds. All areas where paint or galvanizing has been removed shall be field repaired with the specified paint or cold galvanizing compound, respectively.
- I. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- J. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.9 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.10 WATERSTOPS

- A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.11 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, and only if specifically noted as withheld on the batch ticket, and **only if specifically approved by Architect, Engineer, or Testing Agency.**
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
 - 2. Water content shall not exceed the maximum specified water/cement ratio for the mix.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
 - 4. Do not permit concrete to drop freely any distance greater than 20'-0" for concrete containing a high range water reducing admixture (superplasticizer) or 5'-0" for other concrete. Provide chute or tremie to place concrete where longer drops are necessary. Do not place concrete into excavations with standing water. If place of deposit cannot be pumped dry, pour concrete through a tremie with its outlet near the bottom of the place of deposit.
 - 5. Pump priming grout shall be discarded and not used in the structure.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 305.1 and as follows:

1. **Maintain concrete temperature below 90 deg F** at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.12 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view, to be covered with a coating, or covering material applied directly to concrete.

3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
1. Housekeeping pads: Concrete fill shall be normal weight concrete, reinforced with 4x4-W2.1xW2.1 welded wire mesh set at middepth of pad. Trowel concrete to a dense, smooth finish. Set anchor bolts for securing mechanical or electrical equipment during pouring of concrete fill.

- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.
1. Mix one part Portland Cement and two parts crushed stone or gravel passing 3/8" sieve and retained on a 1/8" sieve, measured by volume with only sufficient water to produce a dry consistency for proper placing and finishing.
 2. Placing: Place fill and reinforcement in all steel pan treads and landings. Reinforcement shall be 2"x2" by 14 gauge welded wire fabric extending over the area of each tread and landings. Support reinforcement 3/4" above bottom of steel pans. After sufficient hardening of the concrete fill, steel trowel the exposed surface to a smooth finish.
 3. Abrasive aggregate: Sprinkle abrasive aggregate into the troweled concrete fill in two shakes at the rate of 1/4 pound per square foot and trowel lightly into the surface.

3.14 INSTALLATION OF NON-SHRINK GROUT UNDER BASE PLATES

- A. Grout under all bearing and baseplates. Comply with manufacturer's instructions. Do not dry pack.
- B. Mixing: Use a mechanical mixer. Add only enough water to make grout placeable. Do not mix more grout than can be used in 20 minutes. Under no circumstances shall grout be retempered.

3.15 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least

12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

- a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
- a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.16 CONCRETE SURFACE REPAIRS

- A. Surface Defects in Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Owner's approval.
- B. Contractor shall submit a detailed, descriptive procedure listing proposed pre-packaged repair materials and methods for the repair of surface defects prior to the start of repair work.
- C. Patching Mortar: Mix, place and finish pre-packaged repair mortar in accordance with manufacturer's instructions.
- D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, minor honeycombs and rock pockets with no exposed reinforcement, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out minor honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface, 1/4 inch deep minimum. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view using pre-packaged repair mortar so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous

locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

- E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include minor spalls, pop outs, honeycombs and rock pockets with no exposed reinforcement, crazing and cracks in excess of 0.01 inch (0.25 mm) wide that do not penetrate to reinforcement, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with patching mortar. Remove defective areas with clean, square cuts, 1/4" deep minimum. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Place, compact, and finish patching mortar to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
 8. Unapproved and defective repairs shall be removed and replaced in accordance with requirements provided by the Engineer at no additional cost to the Owner.

3.17 STRUCTURAL REPAIRS

- A. Structurally Defective Concrete: Structural defects include spalls, honeycombs or rock pockets with exposed reinforcement, hollow-sounding concrete, cracks that penetrate to the reinforcement or completely through concrete elements, inadequate cover over reinforcement, and other conditions that affect the structural performance or durability of the concrete as determined by the Engineer.
- B. Repair structural defects in concrete in accordance with plans, specifications, details, etc. provided by the Engineer.
1. The cost of the additional services provided by the Engineer to prepare the repair documents, and to oversee the repair work shall be borne by the Contractor.
- C. Unapproved and defective repairs shall be removed and replaced in accordance with requirements provided by the Engineer at no additional cost to the Owner.

3.18 CLEANUP

- A. Imperfect or damaged work or any material damaged or determined to be defective before final completion and acceptance of the entire job shall be satisfactorily replaced at the Contractor's expense, and in conformity with all of the requirements of the Drawings and Specifications. Removal and replacement of concrete work shall be done in such manner as not to impair the appearance or strength of the structure in any way.
- B. Cleaning: Upon completion of the work all forms, equipment, protective coverings and any rubbish resulting therefrom shall be removed from the site. After sweeping floors, wash floors with clean water. Finished concrete surfaces shall be left in a clean condition, satisfactory to the Owner.

3.19 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner may engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections may include:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Headed bolts and studs.
 - 4. Verification of use of required design mixture.
 - 5. Concrete placement, including conveying and depositing.
 - 6. Curing procedures and maintenance of curing temperature.
 - 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure four cylinders for each composite sample.

- 1) Do not transport field-cast cylinders until they have cured for a minimum of 24 hours.
 - b. Cast and field cure four cylinders for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39/C 39M;
 - a. Test one cylinder at 7 days
 - b. Test two cylinders at 28 days
 - c. Test one cylinder at 56 days
 - d. If 4" by 8" cylinders are used, provide 1 additional cylinder at each stage
 8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
 9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 - a. When the strength level of the concrete for any portion of the structure, as indicated by cylinder tests, falls below the specified requirements, the Contractor shall provide improved curing conditions and/or adjustments to the mix design as required to obtain the required strength. If the average strength of the laboratory control cylinders falls so low as to be deemed unacceptable, the Contractor shall follow the core test procedure set forth in ACI 301, Section 1.6. Locations of core tests shall be approved by the Architect. Core sampling and testing shall be at Contractors expense.
 - b. If the results of the core tests indicate that the strength of the structure is inadequate, any replacement, load testing, or strengthening as may be ordered by the Architect shall be provided by the Contractor without cost to the Owner.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.
- D. Testing of Slabs Containing MVRA:
1. Testing: Retain a qualified testing agency to perform tests and to submit reports.
 2. Concrete Tests:

- a. Maintain four (4) inch concrete cylinders for a minimum of one (1) year from date of Substantial Completion.
- b. Test cylinders as required by warranty or in accordance with supplier's recommendations.
- c. Test cylinders to demonstrate that the minimum waterproofing is 61×10^{-8} cm/s in accordance with ASTM D5084.
- d. Frequency: Test one (1) cylinder per project with the cost borne by the admixture supplier.
- e. Moisture Testing: The WVRA supplier will perform all field moisture testing using ASTM D 4263-83(2102) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method-Modified for Numerical Value. Ambient conditions shall be 70 F and 50% Relative Humidity and the moisture rise shall be no more than 0.5%. Consult with manufacturer for testing protocols.
- f. Bond Testing: Warranted moisture sensitive coatings and adhesives must be installed by each subcontractor in coordination with WVRA manufacturer. Bond test results will be evaluated by WVRA manufacturer as part of the Warranty process.
- g. Report test results in writing to Architect, WVRA supplier, and Contractor within 48 hours of testing. Test reports shall contain project name and number, date of WVRA application, name of testing agency, location of concrete batch in Work, concrete mix proportions and materials, and waterproofing capability.
- h. Additional Tests: Testing agency shall make additional tests of concrete when test results indicate that water vapor reducing admixture capability requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders or by other methods as directed by Architect.
- i. Additional testing, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- j. Correct deficiencies in the Work that test reports indicate do not comply with the Contract Documents.

- E. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.

END OF SECTION 03 30 00

SECTION 03 35 00
CONCRETE FLOOR FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Finishing slabs-on-grade, monolithic floor slabs, and separate floor toppings.
 - 2. Surface treatment with concrete hardener, sealer, and slip resistant coatings.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for concrete slab construction and finish.
 - 2. Division 7 Section "Joint Sealers"
 - 3. Division 9 Section "Ceramic Tile" for medium-set and thickset mortar beds for tile.

1.3 REFERENCES

- A. The latest adopted edition of all standards referenced in this section shall apply, unless noted otherwise.
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 302 - Guide for Concrete Floor and Slab Construction
 - 3. ASTM E1155 - Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound Units).

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- B. Submittals
 - 1. Product Data: Submit manufacturer's data showing compliance with the specifications for the following products:
 - a. Concrete hardener
 - b. Sealer
 - c. Slip resistant treatments

- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."
 - 1. The Contractor shall call a meeting to review the detailed requirements for floor construction, including the concrete placing techniques, finishing techniques, curing techniques, and the application of floor finishing materials. All contractors involved in the floor installation shall attend the conference.
 - 2. The Contractor shall notify the Owner, Architect and the Structural Engineer at least 10 business days prior to the scheduled date of the conference.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.
- B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2.2 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.
 - 1. Products:
 - a. Burke by Edoco; Titan Hard.
 - b. ChemMasters; Chemisil Plus.
 - c. ChemTec International; ChemTec One.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Intraseal.
 - e. Curecrete Distribution Inc.; Ashford Formula.
 - f. Dayton Superior Corporation; Day-Chem Sure Hard.
 - g. Euclid Chemical Company (The); Euco Diamond Hard.
 - h. Kaufman Products, Inc.; SureHard.
 - i. L&M Construction Chemicals, Inc.; Seal Hard.
 - j. Meadows, W. R., Inc.; Liqui-Hard.
 - k. Metalcrete Industries; Floorsaver.
 - l. Nox-Crete Products Group, Kinsman Corporation; Duranox.
 - m. Symons Corporation, a Dayton Superior Company; Buff Hard.
 - n. US Mix Products Company; US Spec Industraseal.
 - o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS.

B. Penetrating sealer:

1. Penetrating sealer shall be a low viscosity, urethane based sealer having at least 35 percent solids. Acceptable products include "Iso-Flex 611", by Master Builders, "Eucothane" by the Euclid Chemical Company, or approved equivalent.

2.3 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

PART 3 - EXECUTION

3.1 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Concrete slabs shall be finished as specified below, within the tolerances specified elsewhere in this Section.
1. Highway straightedges are recommended for use in lieu of bullfloats for all slab placement and finishing operations.
 2. Screeding: Immediately after placing, slab shall be vibrated and struck off true by double screeding to the required level, at or below the elevation or grade of the finished slabs as indicated on the Drawings. Vibrators shall not be used to spread the concrete. When camber is indicated for slabs supported on formwork, screed to the required camber. Fixed screed guides are recommended where specified surface tolerance exceeds FF25/FL20.
 3. Floating: Immediately after screeding, before any excess bleed water is present on the surface, float the surface using long-handled bull floats or darbies.
 4. Straightedging: Immediately after screeding and before excess bleed water is present on the surface, straighten the surface using a highway straightedge.
 5. Edging and jointing, where required, shall be done after bleed water has evaporated and before further finishing.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces to receive trowel finish.
 2. Locations: All concrete surfaces under waterproofing membrane, setting beds for brick, mud-set tile, pavers, or terrazzo, and noncomposite topping slabs.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces exposed to view.
 2. Locations: Exposed concrete floors not otherwise specified, concrete surfaces under carpets, vinyl tile, thin set tile, wood flooring, elastomeric coatings, and painted concrete floors, and roof slabs that are future floors.

- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
 - 1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
 - 2. After broadcasting and tamping, apply float finish.
 - 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

3.2 FINISHING CONCRETE TOPPING SLABS

- A. Place concrete floor topping continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.
 - 1. Screed surface with a straightedge and strike off to correct elevations.
 - 2. Slope surfaces uniformly where indicated.
 - 3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.
- B. Finishing: Consolidate surface with power-driven floats as soon as concrete floor topping can support equipment and operator. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until concrete floor topping surface has a uniform, smooth, granular texture.
 - 1. Hard Trowel Finish: After floating surface, apply first trowel finish and consolidate concrete floor topping by power-driven trowel without allowing blisters to develop. Continue troweling passes and restraighten until surface is smooth and uniform in texture.
 - a. Finish surfaces to specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15, and measure within 24 hours according to ASTM E 1155 for a randomly trafficked floor surface.
 - b. Finish and measure surface so gap at any point between surface and an unleveled freestanding 10-foot- long straightedge, resting on 2 high spots and placed anywhere on the surface, does not exceed 1/4 inch.

3.3 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply to concrete that is less than seven days' old.
 - 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.4 CONCRETE FINISH MEASUREMENT AND TOLERANCES

- A. All floors are subject to measurement for flatness and levelness and shall comply with the following:
 - 1. Slabs shall be flat within a tolerance of 5/16" in 10'-0" when tested with a ten foot long straightedge. Apply straightedge to the slab at 3'-0" intervals in both directions, lapping straightedge 3'-0" on areas previously checked. Low spots shall not exceed the above dimension anywhere along the straightedge. Flatness shall be checked the next work day after finishing.
 - 2. Slabs shall be level within a tolerance of plus or minus 1/4" in 10'-0", not to exceed 3/4" total variation, anywhere on the floor, from elevations indicated on the Drawings. Levelness shall be checked on a 10'-0" grid using a level after removal of forms.
 - 3. Measurement Standard: All floors are subject to measurement for flatness and levelness, according to ASTM E1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System."
- B. Two Tiered Measurement Standard: Each floor test section and the overall floor area shall conform to the two-tiered measurement standard as specified herein.
 - 1. Minimum Local Value: The minimum local FF/FL values represent the absolute minimum surface profile that will be acceptable for any one test sample (line of measurements) anywhere within the test area.
 - 2. Specified Overall Value: The specified overall FF/FL values represent the minimum values acceptable for individual floor sections as well as the floor as a whole.
- C. Floor Test Sections
 - 1. A floor test section is defined as the smaller of the following areas:
 - a. The area bounded by column and/or wall lines.
 - b. The area bounded by construction and/or control joint lines.
 - c. Any combination of column lines and/or control joint lines.
 - 2. Test sample measurement lines within each test section shall be multidirectional along two orthogonal lines, as defined by ASTM E1155, at a spacing to be determined by the Owner's testing agency.
 - 3. The precise layout of each test section shall be determined by the Owner's testing agency.

D. Concrete Floor Finish Tolerance

1. The following values apply before removal of shores. Levelness values (FL) do not apply to intentionally sloped or cambered areas, nor to slabs poured on metal deck or precast concrete.
 - a. Suspended/Structured Slabs:
 - 1) Floors to be covered with carpet or vinyl tile, unless otherwise specified:
 - a) Overall Value FF25/FL20
 - b) Minimum Local Value FF17/FL15
 - 2) Floors to be covered with thin-set tile:
 - a) Overall Value FF35/FL20
 - b) Minimum Local Value FF24/FL15
 - 3) Mechanical rooms, thickset tile, recessed floors and roof slabs:
 - a) Overall Value FF20/FL15
 - b) Minimum Local Value FF15/FL10

E. Floor Elevation Tolerance Envelope:

1. The acceptable tolerance envelope for absolute elevation of any point on the slab surface, with respect to the elevation shown on the Drawings, is as follows:
 - a. Slab-on-Grade Construction: $\pm 3/4"$ Typ. U.N.O.
 - b. Top surfaces of formed slabs measured prior to removal of supporting shores: $\pm 3/4"$
 - c. Top surfaces of all other slabs: $\pm 3/4"$
 - d. Slabs specified to slope shall have a tolerance from the specified slope of $3/8"$ in 10'-0" at any point, up to $3/4"$ from theoretical elevation at any point.

3.5 FIELD QUALITY CONTROL

A. Concrete Floor Flatness and Levelness:

1. Measurement Standard: Floors shall be measured for flatness and levelness according to ASTM E1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System." Tolerances are specified in Section 033000.
2. Time Period for Measuring and Reporting: All measurements shall be made by the testing laboratory or designated agency before the end of the next workday after the completion of finishing operations. For structural elevated floors, measurement shall also be made prior to removal of forms and shores. The Contractor shall be notified immediately after the measurements of any section are complete, and a written report of the floor measurement results shall be submitted within 72 hours after finishing operations are complete. The Contractor shall take immediate action to correct any work that is outside the specified tolerances.
3. Measuring Equipment: The concrete surface profile shall be measured using equipment manufactured for the purpose, such as the Dipstick Floor Profiler, as manufactured by the Edward W. Face Company, Norfolk, Virginia, or by other methods specified in ASTM E1155.
4. Floor Test Sections:
 - a. A floor test section is defined as the smaller of the following areas:
 - 1) The area bounded by column and/or wall lines.

- 2) The area bounded by construction and/or control joint lines.
 - 3) Any combination of column lines and/or control joint lines.
- b. Test sample measurement lines within each test section shall be multidirectional along two orthogonal lines.
 - c. The precise layout of each test section shall be determined by the testing agency and shall be submitted for the Architect's review and approval.

3.6 REPAIRS

- A. Defective Topping: Repair and patch defective concrete floor topping areas, including areas that have not bonded to concrete substrate.
- B. Remedial Measures for Slab Finish Construction not Meeting Specified Tolerances:
 - 1. Application of Remedial Measures. Remedial measures specified herein are required whenever either or both of the following occur:
 - a. The composite overall values of flatness or levelness of any test section or the entire floor installation measure less than specified values.
 - b. Any individual test sample (line of measurements) measures less than the specified absolute minimum flatness or levelness value.
 - 2. Modification of Existing Surface:
 - a. If, in the opinion of the Architect or Owner's representative, all or any portion of the substandard work can be repaired without sacrifice to the appearance or serviceability of the area, the Contractor shall immediately undertake the approved repair method.
 - b. The Contractor shall submit for review and approval a detailed work plan of the proposed repair showing areas to be repaired, method of repair, and time required to make the repair.
 - c. Repair method(s), at the sole discretion of the Architect or Owner's Representative, may include grinding (floor stoning), planing, retopping with specified floor leveling compound, or any combination of the above.
 - d. All repair work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.
 - 3. Removal and Replacement:
 - a. If, in the opinion of the Architect/Engineer or Owner's Representative, all or any portion of the substandard work cannot be satisfactorily repaired without sacrifice to the appearance or serviceability of the area, the Contractor shall remove and replace the defective work as directed.
 - b. Replacement sections may be retested for compliance at the discretion of the Architect/Engineer or Owner's Representative.
 - c. All replacement work shall be performed at no additional cost to the Owner and with no extension to the construction schedule.

END OF SECTION 03 35 00

SECTION 033536

CLEAR CONCRETE SEALER

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents: Conditions of the Contract, Division 01 - General Requirements, and Drawings are applicable to Work of this Section.
- B. Related Sections:
 - 1. Section 03300 - Cast-in-Place Concrete.
- C. **Section Includes:**
 - 1. **Clear sealer to be applied to all exposed concrete floors inside building unless otherwise indicated on finishes plans and contract documents.**

1.2 SUBMITTALS

- A. General: Submit in accordance with Section 007013 and Section 013100.
- B. **Product Data:** Submit manufacturer's technical literature, including chemical properties and percentage of solids, for each product.

1.3 QUALITY ASSURANCE

- A. **Applicator Qualifications:** Performed by firm with **10 years minimum experience** in application of sealer required for Project.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of Division 1.
- B. Store products above 50°F, but no greater than 85°F, unless otherwise recommended by manufacturer.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. **Do not apply materials when ambient or substrate surface temperatures are below 40 degrees F or higher than 100 degrees F.**
- B. **Do not apply during inclement weather** or when forecasted conditions will not permit compliance with manufacturer's printed instructions.
- C. Provide mechanical ventilation during and after application to dissipate fumes if natural ventilation is insufficient.

1.6 SEQUENCING AND SCHEDULING

- A. Schedule application of products at proper time intervals after concrete finishing and curing operations.
- B. Maintain proper moisture content of concrete before, during, and after application of specified products.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. **Liquid Membrane-Forming Sealer (for use on concrete floor slabs intended to be left exposed):**
 - 1. **Acceptable products:**
 - a. The Euclid Chemical Company; Eucocure VOX, Acrylic Curing and Sealing Compound.
 - b. Dayton Superior Corporation; Safe Cure & Seal (J-18).

- c. Lambert Corporation; Exposite WB.
- 2. Substitutions: Submit in accordance with Section 016000.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 014300.
- B. Verify that surfaces are clean, dry, dust free, and free of efflorescence, oil or other matter detrimental to sealer application. If required, mechanically abrade surfaces to be coated for proper substrate characteristics.
- C. Verify that joint sealant work in adjoining surfaces is complete prior to applications of sealers. Delay application until sealants have cured.
- D. **Ensure concrete has cured for time period required by manufacturer of product to be applied (28 days minimum before application of products).**
- E. Verify that damage and defects in concrete surface have been repaired as specified in Section 03 30 00 and accepted by Architect.

3.2 PREPARATION

- A. Remove loose particles, foreign matter, and oil by method which will not affect sealer application.
- B. Prepare surfaces in accordance with manufacturer's directions.
- C. Provide protection as necessary to protect adjacent materials and surfaces from dirt, dust, spillage, overspray and other surface or physical damage.

3.3 APPLICATION

- A. General:
 - 1. Provide finishes to match approved samples at locations indicated.
 - 2. Apply materials in accordance with manufacturer's printed instructions.
- B. **Liquid Membrane-Forming Sealer:**
 - 1. **Apply sealer using low pressure airless sprayer in single coat** at 250 ft/gal (6.0-7.0 WFT) coverage unless greater amount is recommended by manufacturer to obtain penetration and full coverage.
 - 2. Do not allow flooding or puddling of material on surface.
 - 3. Do not dilute or alter material as packaged.
 - 4. **Locations: As indicated on plans and on all exposed concrete flooring inside of building.**

3.4 ADJUSTING

- A. Repair or replace adjacent Work which has been damaged by finishing operations.

3.5 CLEANING

- A. Clean spillage, overspray, or drift from adjacent surfaces; remove immediately in accordance with manufacturer's instructions.

3.6 PROTECTION

- A. Protect finished concrete surfaces from damage by construction equipment, operations and from adverse weather conditions.

END OF SECTION

SECTION 042000

UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. **Concrete masonry units and burnished units.**
 - 2. **Face brick and special shapes.**
 - 3. **Thin brick and backup panels.**
 - 4. **Mortar and grout.**
 - 5. **Steel reinforcing bars.**
 - 6. **Masonry joint reinforcement.**
 - 7. **Ties and anchors.**
 - 8. **Embedded flashing.**
 - 9. **Miscellaneous masonry accessories.**

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 SUBMITTALS

- A. **Product Data:** For each type of product indicated.
- B. **Samples for Verification:** For each type and color of the following:
 - 1. **Face brick.**
 - 2. **Special brick shapes and solid brick units.**
 - 3. **Thin brick.**
 - 4. **Pigmented mortar.** Make Samples using same sand and mortar ingredients to be used on Project.
 - 5. **Weep holes and vents.**
 - 6. **Accessories embedded in masonry.**
- C. **Qualification Data:** For testing agency.
- D. **Material Certificates:** For each type and size of the following:
 - 1. **Masonry units:**
 - a. Include data on material properties.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence according to ASTM C 67.
 - d. For masonry units, include data and calculations establishing average net-area compressive strength of units.
 - 2. **Cementitious materials.** Include brand, type, and name of manufacturer.
 - 3. **Pre-blended, dry mortar mixes.** Include description of type and proportions of ingredients.
 - 4. **Grout mixes.** Include description of type and proportions of ingredients.
 - 5. **Reinforcing bars.**
 - 6. **Joint reinforcement.**
 - 7. **Anchors, ties, and metal accessories.**
- E. **Statement of Compressive Strength of Masonry:** For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units,

mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
- G. Shop drawings showing size, placement, and location of reinforcing steel.

1.5 **QUALITY ASSURANCE**

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- D. Mockups: Refer to mockup requirements in Section 014000. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Construct masonry in mock-up with correct substrate backup, mortar, special shapes, solid units, bonding, joint work, reinforcement, grouting, mortar colors, expansion and control joints, window, and accessories specified in the Contract Documents for the project.
 - 2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
 - 3. **Clean only one-half of exposed faces** of mockups with masonry cleaner as specified for Architect's initial approval. Then clean remainder.
 - 4. Protect accepted mockups from the elements with weather-resistant membrane.
 - 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect, in writing.
- E. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 **DELIVERY, STORAGE, AND HANDLING**

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
 - 2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. **Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface by covering wall surfaces below with plastic or other appropriate materials.**
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

- A. **Defective Units:** Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. **Fire-Resistance Ratings:** Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Regional Materials: Provide CMUs that have been manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide square-edged units for outside corners unless otherwise indicated.
- C. Burnished CMU: Not used.
- D. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) ACM Chemistries; RainBloc.
 - 2) BASF Aktiengesellschaft; Rheopel Plus.
 - 3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.
 - E. CMUs: ASTM C 90.
 1. **Unit Compressive Strength:** Provide units with minimum average net-area compressive strength of 2150 psi.
 2. **Density Classification:** Lightweight.
 3. **Size (Width):** Manufactured to dimensions 3/8 inch less than nominal dimensions.
 4. **Exposed Faces:** Provide color and texture matching the range represented by Architect's sample.
- 2.3 **CONCRETE AND BURNISHED CMU BLOCK LINTELS**
- A. General: Provide one of the following:
 - B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than CMUs.
 - C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.
- 2.4 **BRICK**
- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Steel shelf angles as specified in Section 055000.
 4. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 5. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
 6. **Provide solid brick units where brick coursing is corbeled or offset from courses above and below.**
 - B. Face Brick: Facing brick complying with ASTM C 216 or hollow brick complying with ASTM C 652, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area).
 1. **Products:** Refer to Section 008900 – Finish Selection Summary.
 2. **Grade:** Refer to Section 008900 – Finish Selection Summary.
 3. **Type:** Refer to Section 008900 – Finish Selection Summary.
 4. **Unit Compressive Strength:** Provide units with minimum average net-area compressive strength of 3350 psi.
 5. **Initial Rate of Absorption:** Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 6. **Efflorescence:** Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 7. **Size:** Refer to Section 008900 – Finish Selection Summary.

8. **Application:** Use where brick is exposed unless otherwise indicated.
 9. Where shown to "match existing," provide face brick matching color range, texture, and size of existing adjacent brickwork.
 10. **Color and Texture:** Refer to 008900 – Finish Selection Summary.
 11. **Special Shapes:** Provide shelf angle units at continuous shelf angle locations.
- C. Thin Brick:
1. **Thin Brick:** Refer to Section 008900 – Finish Selection Summary.
 2. **Mounting System:** TABS Wall Systems, LLC; TABS II.

2.5 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Provide aggregate for mortar and grout, cement, and lime that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Masonry Cement: ASTM C 91.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. **Acceptable Product:** To be selected by Architect from any manufacturer's full and complete lines of products, including custom colors.
- G. Aggregate for Mortar: ASTM C 144.
 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
- H. Aggregate for Grout: ASTM C 404.
- I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.
- J. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951.
 1. Interior Walls: Hot-dip galvanized, carbon steel.
 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 3. Wire Size for Side Rods: 0.187-inch diameter.
 4. Wire Size for Cross Rods: 0.187-inch diameter.
 5. Wire Size for Veneer Ties: 0.187-inch diameter.
 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.7 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
 1. **Hot-Dip Galvanized, Carbon-Steel Wire:** ASTM A 82; with ASTM A 153, Class B-2 coating.
 2. **Galvanized Steel Sheet:** ASTM A 653, Commercial Steel, G60 Z180 zinc coating.
 3. **Steel Sheet, Galvanized after Fabrication:** ASTM A 1008, Commercial Steel, with ASTM A 153, Class B coating.

4. **Steel Plates, Shapes, and Bars:** ASTM A 36.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
 1. Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
 2. Wire: Fabricate from 3/16-inch diameter, hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.
- D. Partition Top Anchors: 0.105-inch-thick metal plate with 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated bent to configuration indicated.
 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153.
- F. **Adjustable Masonry-Veneer Anchors:**
 1. **General:** Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. **Structural Performance Characteristics:** Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
 2. **Screw-Attached, Masonry-Veneer Anchors:** Units consisting of a wire tie and a metal anchor section.
 - a. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - 1) Hohmann & Barnard, Inc.; HB-213-2X with X-Seal Tape beneath anchors.
 - b. **Anchor Section:** Gasketed sheet metal anchor section, 1-1/4 inches (32 mm) wide by 6 inches (152 mm) long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch (16 mm) wide by 6 inches (152 mm) long, stamped into center to provide a slot between strap and base for inserting wire tie. Self-adhering, modified bituminous tape fits behind anchor plate and extends beyond pronged legs.
 - c. Fabricate sheet metal anchor sections and other sheet metal parts from 0.105-inch-thick, steel sheet, galvanized after fabrication.
 - d. **Wire Ties:** Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch-diameter, hot-dip galvanized steel wire.
 3. **Polymer-Coated, Steel Drill Screws for Steel Studs:** ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
 - a. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - 1) ITW Buildex; Teks Maxiseal with Climaseal finish.
 - 2) Textron Inc., Textron Fastening Systems; Elco Drill-Flex with Stalgard finish.

2.8 **EMBEDDED FLASHING MATERIALS**

- A. Refer to Section 076210, Flexible Flashing.
- B. Rubberized Asphalt Flashing:
 1. Basis of Design: Henry Blueskin TWF.
 2. Other Acceptable Manufacturers:
 - a. GBP.

- b. Polyguard.
- c. Protectowrap.
- 3. Sheet Membrane: Rubberized asphaltic sheet laminated to a polypropylene film, 32 mil minimum total thickness, width as required for joints and flashing conditions.
- 4. Primer: Rubber based solvent type recommended by membrane manufacturer.
- 5. Mastic: Rubberized asphaltic type recommended by membrane manufacturer.
- 6. Liquid Membrane: Two component elastomeric, mastic grade.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. **Compressible Filler:** Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. **Preformed Control-Joint Gaskets:** Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. **Bond-Breaker Strips:** Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. **Weep/Vent Products:** Use one of the following unless otherwise indicated:
 - 1. **Cellular Plastic Weep/Vent:** One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - 1) Advanced Building Products Inc.; Mortar Maze weep vent.
 - 2) Blok-Lok Limited; Cell-Vent.
 - 3) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
 - 4) Heckmann Building Products Inc.; No. 85 Cell Vent.
 - 5) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 6) Wire-Bond; Cell Vent.
- E. **Cavity Drainage Material:** Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. Archovations, Inc.; CavClear Masonry Mat.
 - c. Mortar Net USA, Ltd.; Mortar Net.
 - 2. **Provide one of the following configurations:**
 - a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.
 - b. Strips, not less than 3/4 inch thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
 - c. Sheets or strips full depth of cavity and installed to full height of cavity.
 - d. Sheets or strips not less than 3/4 inch thick and installed to full height of cavity with additional strips 4 inches high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from clogging with mortar.
- F. **Reinforcing Bar Positioners:** Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
 - 1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.

- c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
- d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.10 MASONRY CLEANERS

- A. Proprietary Non-Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. **Basis of Design:** ProSoCo, Inc.; Sure Klean.
 - 2. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.
 - 3. **Do not use muratic acid under any circumstances!**

2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. **Do not use calcium chloride in mortar or grout.**
 - 2. Use portland cement-lime masonry cement mortar unless otherwise indicated.
 - 3. For exterior masonry, use portland cement-lime masonry cement mortar.
 - 4. For reinforced masonry, use portland cement-lime masonry cement mortar.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. **Mortar for Unit Masonry:** Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. **For masonry below grade or in contact with earth, use Type M.**
 - 2. **For reinforced masonry, use Type S.**
 - 3. **For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.**
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Pigments shall not exceed 5 percent of masonry cement by weight.
 - 3. Mix to match Architect's sample.
 - 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Face brick.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified **28-day compressive strength indicated, but not less than 2000 psi.**
 - 3. **Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Do not allow discernible patterns such as chevrons to occur.
- F. Mix units from several pallets or cubes as they are placed.
- G. Matching Existing Masonry: Where called for on Drawings or Section 008900 Finish Selection Summary match coursing, bonding, color, and texture of existing masonry where applicable.
- H. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

- A. **Dimensions and Locations of Elements:**
 - 1. **For dimensions in cross section or elevation:** Do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. **For location of elements in plan:** Do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. **For location of elements in elevation:** Do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. **Lines and Levels:**
 - 1. **For bed joints and top surfaces of bearing walls:** Do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 2. **For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals:** Do not vary from level by more than 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 3. **For vertical lines and surfaces:** Do not vary from plumb by more than 3/8 inch in 20 feet, or 1/2 inch maximum.
 - 4. **For conspicuous vertical lines:** Such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 5. **For lines and surfaces:** Do not vary from straight by more than 3/8 inch in 20 feet, or 1/2 inch maximum.
 - 6. **For vertical alignment of exposed head joints:** Do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

7. **For faces of adjacent exposed masonry units:** Do not vary from flush alignment by more than **1/16 inch** except due to warpage of masonry units within tolerances specified for warpage of units.
- C. **Joints:**
 1. **For bed joints:** Do not vary from thickness indicated by more than **plus or minus 1/8 inch, with a maximum thickness limited to 3/8 inch.**
 2. **For exposed bed joints:** Do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch with a maximum thickness limited to 3/8 inch.**
 3. **For head and collar joints:** Do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
 4. **For exposed head joints:** Do not vary from thickness indicated by more than plus or minus **1/8 inch with a maximum thickness of 3/8 inch.** Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 5. **For exposed bed joints and head joints of stacked bond:** Do not vary from a straight line by more than **1/16 inch** from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Mortar joints shall not exceed 3/8" in width or height.
- B. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- C. Bond Pattern for Exposed Masonry: Refer to Section 008900 – Finish Selection Summary; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- E. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- F. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- G. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- I. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- J. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

Install compressible filler in joint between top of partition and underside of structure above.

 1. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
 2. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Fire-Resistive Joint Systems."
- K. **Install brick units consisting of blended units such that patterning is not visible.** Any distinct patterns such as chevrons or heavy groupings of one or more colors shall be removed and reinstalled to eliminate patterns.
- L. **Use of Solid Masonry Units:** Use solid bricks shapes at rustication (recessed) courses, corners and corbelled courses. Solid units shall match typical units in appearance.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMUs as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. **Tool exposed joints slightly concave** when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:
 - 1. **Fasten screw-attached anchors through sheathing to wall framing** with metal fasteners of type indicated. Use two fasteners per anchor unless anchor design only uses one fastener.
 - 2. **Embed tie sections in masonry joints.** Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing unless shown otherwise on Drawings.
 - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 4. **Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally** (or 12 inches on center vertically and 32 inches on center horizontally) with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.7 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick as follows:
 - 1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 - 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 - 3. Build in compressible joint fillers where indicated.
 - 4. Form open joint full depth of brick wythe and of width indicated, but **not less than 3/8 inch** for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."

- D. Provide horizontal, pressure-relieving joints by inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than **3/8 inch (larger where indicated)**.
 - 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.
- E. **Vertical control joints shall be installed not more than 20 ft. O.C. and as recommended by BIA standards whichever is more restrictive.** Coordinate final locations with Architect prior to installation of masonry.

3.8 LINTELS AND SHELF ANGLES

- A. Install steel lintels where indicated and as otherwise required by structural engineer, and per best practices.
- B. Provide concrete masonry lintels where shown and as required where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of **8 inches** at each jamb unless otherwise indicated.
- D. Provide continuous steel shelf angles at 30' maximum above first floor slab and at each floor above that height. Provide whether or not shown on Drawings.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. **Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar.** Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. **At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper, air barrier, or building wrap, lapping at least 4 inches.**
 - 3. **At lintels and shelf angles,** extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and **turn up not less than 2 inches to form end dams.**
 - 4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
 - 5. Install metal drip edges and sealant stops where required, with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
 - 6. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
 - 1. Use specified weep/vent products to form weep holes.
 - 2. Space weep holes 24 inches o.c. unless otherwise indicated.

- F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.10 INSTALLING THIN BRICK MOUNTING PANEL

- A. Backup Panels:
 - 1. Attach to wall substrate with screws into metal studs.
 - 2. Attach the anchors near the pocket edges so that prongs are visible with thin brick units in place.
 - 3. Apply adhesive beads over the adhesive locks.
- B. Thin Brick Units: Place thin brick on the brick supports and push adhesive through the backup panel.
- C. Work Pattern: Begin work at bottom of wall and proceed up according to manufacturer's instructions.
- D. Joints:
 - 1. Using a grout bag, fill joints with mortar.
 - 2. Finish joints that will remain exposed with a tool slightly larger than joint width to form a concave profile. Tool joints after mortar has taken its initial set and in such a manner as to squeeze mortar back into joint.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. **Limit height of vertical grout pours to not more than 60 inches.**

3.12 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Level 1 special inspections according to the "International Building Code."
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Mortar and Grout Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

- G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
- J. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.13 **REPAIRING, POINTING, AND CLEANING**

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 3. **Protect adjacent stone and non-masonry surfaces from contact with cleaner** by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
 8. **Clean stone trim to comply with stone supplier's written instructions.**
 9. **Do not used muratic acid. No exceptions!**

3.14 **MASONRY WASTE DISPOSAL**

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 047200

CAST STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Custom cast stone wall caps, copings, watermarks, base courses, and belt courses.**
- B. **Custom cast stone units, shapes, and fabrications.**
- C. **Reinforcement, anchorages and accessories.**

1.3 PERFORMANCE REQUIREMENTS

- A. **Delegated Design:** Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," licensed in the state where the work is being performed to design anchorages to back-up walls for each condition indicated, including detailed reinforcing and stainless steel pinned connection requirements.

1.4 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Shop Drawings:**
 - 1. Provide Shop Drawings, signed and sealed by professional engineer.
 - 2. Indicate sizes, shapes, materials, reinforcement, joint details, locations, and anchorage.
- C. **Samples:** Submit two – 24" long samples of each cast stone shape and finish for Architect's approval.
- D. Submit manufacturer's installation instructions.
- E. Provide mockup at site.

1.5 QUALITY ASSURANCE

- A. **Manufacturer: Minimum 10 years experience** fabricating similar work. Submit list of recently completed projects if requested.
- B. **Installer: Minimum of 10 years experience** in similar types of work and is able to furnish a list of previous projects and references if requested by the Architect.
- C. **Manufactured Units:** Meet requirements of FS SS-S- 721C.
- D. **Standards:** Comply with Cast Stone Institute and Brick Industry of American recommendations and standards.

1.6 CERTIFICATES

- A. Submit manufacturer's certificates that materials meet or exceed specified requirements.
 - 1. **Manufacturer is a producing member of the Cast Stone Institute** and has on file and follows a written quality-control plan that includes all elements of the Cast Stone Institute's "Quality Control Procedures Required for Plant Inspection."

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after, installation. In hot weather (above 99 degrees with less than 50% relative humidity), protect construction from direct exposure to the sun and wind.
- B. **Cold weather requirements:** IMIAC - Recommended Practices and Specifications for Cold Weather Masonry Construction.

1.8 DELIVERY AND STORAGE

- A. Deliver, store and handle materials in accordance with Section 016000.

- B. After curing, store, stack, and transport in a manner to prevent cracking, chipping, spalling, staining, and other injuries.
 - C. Store stone off the ground and under cover.
- 1.9 PROTECTION
- A. Protect stone to prevent concrete, asphalt, rainwater, and other foreign material from defacing stone surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Advanced Cast Stone.
- B. United Commercial Cast Stone
- C. Better Cast Stone
- D. Continental Cast Stone
- E. Substitutions: Under provisions of Section 016000.

2.2 BASIS-OF-DESIGN PRODUCT

- A. **As indicated in Section 008900 – Finish Selection Summary.**
- B. Appearance: Cast stone units appearance shall be a consistent color with no black particles or sand on the surface.

2.3 MATERIALS

- A. **Portland Cement:** ASTM C 150, Type 1, in **color required to achieve basis of design selection.**
- B. Coarse Aggregates: ASTM C 33, color as necessary to obtain final approved color of stone.
- C. **Sand:** ASTM C 144, as required to match Architect's control sample.
- D. **Lime Putty:** Hydrated lime, Type S, ASTM C 207.
- E. **Reinforcement Steel:** ASTM A 615, Grade 60, domestic deformed steel bars, and ASTM A 82 plain, cold-drawn steel. Hot dip galvanize after fabrication, per ASTM A 153.
- F. **Anchors: Type 303 stainless steel wire and rods,** sizes as detailed.
- G. **Water:** Clean and free from deleterious substances.
- H. **Clear Sealer:** Non-yellowing type as recommended by cast stone manufacturer.
 - 1. **Approved Products:**
 - a. NCP Klearseal as made by National Construction Products, Dallas, Texas
 - b. Klere- Seal 900 as made by Pecora Corp.

2.4 MORTAR MIX

- A. Refer to Section 042000 for mortar requirements.

2.5 FABRICATION

- A. Reinforcement: Reinforce stone with wire and steel reinforcement bars as detailed or as necessary for structural integrity.
- B. **Stone:**
 - 1. Fabricate stone in accordance with referenced standards.
 - 2. **Minimum compressive strength at 28 days of age: 6,500 PSI.**
 - 3. Moisture Absorption: Maximum 8 percent when tested according to ASTM C 97.
 - 4. True to dimensions and profiles with sharp, straight edges and uniform curves.
 - 5. **Do not silicone coat cast stone. Confirm sealer with Architect.**
- C. **Sealer: Apply 2 coats of clear sealer to exposed surfaces of stone at rate of 200 square feet per gallon, per coat.** Apply in accordance with manufacturer's direction. Allow first coat to dry before applying second coat. Do not coat mortar setting or joint surfaces with sealer.
- D. **Anchors:** Provide necessary dowel holes in stone.
- E. **Finish:**

1. **Exposed Surfaces:** Uniformly textured, entirely free of pits, holes, or form marks.
2. **Texture:** Similar in texture to sand finished limestone.
3. **Color:** Provide **white sand, white portland cement, and titanium oxide additive** as required to achieve the most **bright white** color possible.
4. Leave unexposed setting surfaces rough.

2.6 TOLERANCES OF UNITS

- A. **Squareness:** Not more than 1/8 inch in 6 feet out of square.
- B. **Warpage:** Not more than 1/8 inch per 6 feet of length.
- C. **Location of Anchors and Inserts:** Deviation of anchors or inserts from center line or location shown on drawings not greater than plus or minus 3/8 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. **Set stainless steel anchor rods in setting bed.**
- B. Set stone plumb, level and true in full beds of mortar.
- C. Grout dowels into holes in stone and secure anchor with stainless steel tie wire.
- D. Leave securely anchored and bonded.
- E. **Notch cast stone and other projections to allow downspouts to pass by vertically without offsets being required. No exceptions.**

3.2 JOINTS

- A. **Provide 1/4 inch wide joints unless noted otherwise on Drawings.** Fill horizontal and projected unit joints to within 1/2 inch of face of unit with mortar as cast stone is set. **On projections at exterior wall, or non-vertical surfaces, fill exterior 1/2 inch of joints with sealant. Refer 079000.** Leave joints tightly tooled and slightly concave.
- B. Refer to Section 042000 – Unit Masonry for additional requirements.

3.3 TOLERANCES OF INSTALLATION

- A. **Variation from Unit to Adjacent Unit:** 1/32 inch maximum.
- B. **Variation from Plane of Wall:** 1/4 inch in 10 feet, and 1/2 inch in 20 feet or more.
- C. **Variation in Joint Thickness:** 1/8 inch in 3 feet.

3.4 CONTROL/EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcing across control joints.
- B. Install resilient control and expansion joint in continuous lengths in accordance with Section 079000.
- C. **Provide expansion and control joints where indicated on the drawings, or, if none shown, per Brick Institute of America or Cast Stone Institute recommendations. Match control joints and expansion joint locations indicated to be provided in masonry directly adjacent to cast stone units. Maximum distance between control joints shall not exceed 20' o.c.**
- D. **Confirm final location in shop drawings with Architect prior to installation.**

3.5 PATCHING

- A. **Patching of minor defects will be permitted if: 1) performed with proper materials, 2) by skilled craftsmen, 3) as approved by Architect, and 4) patched areas blend-in with surrounding areas so that repair is not noticeable from viewing distance. Unacceptable patches shall be replaced with new cast stone units.**

3.6 CLEANING

- A. After stones are installed, remove foreign matter from surface of stone using a stiff brush, mild cleanser, and clear water.

- B. Contact the manufacturer for advice on how to clean the cast stone. **DO NOT** use any cleaner that could result in yellowing or a change in color of the cast stone over time.
- C. **Use of acid for cleaning of cast stone is strictly prohibited.**

END OF SECTION

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

1. Structural steel framing members and connections.
2. Deck support angles.
3. Shop prime painting and touch up painting in the field.
4. Temporary construction bracing.
5. Fabrication and erection inspection and testing.
6. Grouting under base plates and bearing plates.

- B. Related Sections include the following:

1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 1 Section "Submittals" for administrative requirements for the submission of shop drawings and other submittals.
3. Division 5 Section "Architecturally Exposed Structural Steel."
4. Division 5 Section "Steel Deck" for field installation of shear connectors.
5. Division 5 Section "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.
6. Division 5 Section "Metal Stairs".
7. Division 9 painting Sections for surface preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC's Steel Construction Manual, edition as referenced in the Building Code.
2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

B. Construction: Type PR, partially restrained.

1.5 SUBMITTALS

A. Submit in accordance with Division 1 Section "Submittals".

B. Submittals for Review

1. Provide complete details and schedules for fabrication and shop assembly of members, erection plans, details, procedures, and diagrams showing sequence of erection of structural steel components.
 - a. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - b. Include embedment drawings.
 - c. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - d. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
2. Shop drawings and erection drawings shall not be made by using reproductions of Contract Drawings.
3. Structural steel members for which shop drawings have not been reviewed shall not be fabricated. Engineer's review shall cover general locations, spacings, and details of design. Omission from shop drawings of any materials required by the Contract Documents shall not relieve the Contractor of the responsibility of furnishing and installing such materials, even though such shop drawings may have been reviewed and returned.

C. Submittals for Information:

1. Product Data: For each type of product indicated.
2. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Connection Calculations: Contractor shall design all connections not specifically detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Texas. Submit design calculations for the connections designed by the contractor, prior to or with the steel shop drawings. Shop drawings containing connections for which calculations have not been received shall be returned unchecked as an incomplete submittal. Calculations shall be retained for the Engineer's file and will not be approved or returned.
 - a. Connections shall be designed in accordance with the requirements specified in the Structural Drawings and Specifications.

- b. Beam connections: Submit a complete calculation for each different beam connection used and detailed on the shop drawings. Conditions which are similar may be grouped together so as to utilize a single connection design.
 - c. Submit complete connection calculations for wind brace connections, truss connections, moment connections and other connections where specified on the Contract Drawings. Each calculation shall identify the location or locations for which the connection applies, the member mark(s) from the Contract Documents, the piece mark(s) from the shop drawings, the member size, the design loading(s), member size, and the end of the member to which the connection applies.
- 4. Welding certificates.
- 5. Qualification Data: For Installer and fabricator.
- 6. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - a. Structural steel including chemical and physical properties.
 - b. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - c. Direct-tension indicators.
 - d. Tension-control, high-strength bolt-nut-washer assemblies.
 - e. Shear stud connectors.
 - f. Shop primers.
 - g. Nonshrink grout.
- 7. Source quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Erector Qualifications: A qualified installer who participates in the AISC Certification Program and is designated an AISC-Certified Erector, Category ACSE or CSE.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.
- C. Fabricator Qualifications: Company specializing in performing the work of this section with minimum 10 years of documented experience.
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel."
- E. The latest adopted edition of all standards referenced in this Section shall apply unless noted otherwise. In case of conflict between these Contract Documents and the referenced standard, the Contract Documents shall govern. In case of conflict between these Contract Documents and the Building Code, the more stringent shall govern.
- F. The Contractor shall furnish fabrication and erection inspection and testing of all welds in accordance with AWS D1.1, Chapter 6. Submit records of inspections and tests to the Owner's testing laboratory for their review. The fabrication and erection inspectors shall be AWS certified welding inspectors.
- G. All materials, fabrication procedures and field erection are subject to verification inspection and testing by the Owner's testing laboratory in both the shop and field. Such inspections and tests

will not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with specified requirements.

- H. Qualifications for Welding Work: Contractor shall be responsible for qualifying welding operators in accordance with the AWS "Standard Qualification Procedure." Provide certification to Owner's testing laboratory that welders to be employed in the work have satisfactorily passed AWS qualification tests. Recertification of welders shall be Contractor's responsibility.
- I. Qualification of Welding Procedures: Contractor shall provide the testing laboratory with welding procedures which are to be used. Welding procedures shall be qualified prior to use in accordance with AWS D1.1, Part B.
- J. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges"
 - 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
 - 3. AISC's "Specification for Structural Steel Buildings"
 - 4. ASTM A6 "Specifications for General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
 - 5. RCSC's "Specification for Structural Joints Using High Strength Bolts."
 - 6. AWS D1.1 "Structural Welding Code"
 - 7. SSPC (Society for Protective Coatings), standards as noted.
 - 8. UL "Fire Resistance Directory."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.

- B. W-Shapes: ASTM A 992/A 992M.
- C. Channels, Angles: ASTM A 36/A 36M.
- D. Plate and Bar: ASTM A 36/A 36M.
- E. For ASTM A6 groups 4 and 5 rolled shapes, spliced or otherwise, connected by full penetration welds, provide material with Charpy V-Notch testing in accordance with ASTM A6, Supplementary Requirement S5. The impact test shall meet the minimum average value of 20 foot pounds absorbed energy at 70 degrees Fahrenheit and shall be conducted in accordance with ASTM A673 and the AISC Specifications for Structural Steel Buildings.
- F. For plates exceeding 2" thickness used in built up members which are spliced or connected by full penetration welds, provide material with Charpy V-Notch testing in accordance with ASTM A6, Supplementary Requirement S5. The impact test shall be conducted by the producer in accordance with ASTM A673, Frequency P and shall meet a minimum average value of 20 ft pounds absorbed energy at 70 degrees Fahrenheit.
- G. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- H. Steel Pipe: ASTM A 53/A 53M, Type E, Grade B.
 - 1. Weight Class: As noted.
 - 2. Finish: Galvanized.
- I. Welding Electrodes: Comply with AWS requirements.
- J. Welding electrodes: AWS D1.1, E70. Welding electrodes used in full penetration welds shall have a minimum Charpy V-Notch toughness of 20 ft.-lbs at -20 degrees Fahrenheit when tested in accordance with ASTM A6.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
 - 1. Finish: Plain.
- C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- D. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.

- 5. Finish: Plain.
- E. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 - 4. Finish: Plain.
- F. Threaded Rods: ASTM A 36/A 36M.
 - 1. Nuts: ASTM A 563 (ASTM A 563M) hex carbon steel.
 - 2. Washers: ASTM F 436 (ASTM F 436M) hardened carbon steel.
 - 3. Finish: Plain.
- G. Drilled expansion bolts shall be one of the following:
 - 1. Kwik Bolt TZ, Hilti, Inc., Tulsa, Oklahoma
 - 2. Strong Bolt 2, Simpson Strong-Tie Company, Inc.
- H. Adhesive Anchors:
 - 1. In concrete:
 - a. HIT RE500-V3 epoxy, Hilti Inc.
 - b. SET-XP epoxy, Simpson Strong-Tie, Inc.
 - c. HIT-HY150 MAX-SD acrylic, Hilti, Inc.
 - 2. In grouted masonry:
 - a. HIT-HY-150 MAX, Hilti, Inc.
 - b. SET epoxy, Simpson Strong-Tie Company, Inc.
 - c. AT acrylic, Simpson Strong-Tie Company, Inc.
 - 3. Adhesive anchor rods: As noted on the drawings.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
- B. Galvanizing Repair Paint: ASTM A 780.
- C. Cold Galvanizing Compound shall be "ZRC" cold galvanizing compound as manufactured by ZRC Worldwide, Marshfield, Massachusetts.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, Grade B, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time, capable of developing a minimum compressive strength of 5,000 psi at 28 days.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges", AISC's "Specification for Structural Steel Buildings", and as indicated on accepted shop drawings.
 - 1. Camber structural-steel members where indicated.
 - 2. Mill tolerances shall conform to ASTM A6. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Plates shall be free of gross discontinuities such as ruptures and delaminations. Plates shall comply with ASTM A578, Level 1.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads. Members in compression joints which depend on contact bearing shall have the bearing surfaces milled to a common plane. Members to be milled shall be completely assembled before milling.
- E. Base Plates: Oversize anchor bolt holes in base plates to facilitate erection as specified in Table 14-2 in AISC 360-05.
- F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning or SSPC-SP 2, "Hand Tool Cleaning."
- G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- H. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.
 2. Provide washers over all slotted holes in an outer ply.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Welds not specified shall be continuous fillet welds designed to develop the full strength of the member. A combination of welds and bolts shall not be used to transmit stress at the same face of any connections. Clean completed welds prior to inspection. Slag shall be removed from all completed welds.
1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
 5. Galvanized surfaces.
 6. Top surfaces of beams which support composite metal floor deck.
 7. Headed shear studs, although overspray is acceptable.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
1. Fill vent holes and grind smooth after galvanizing.

- B. Galvanizing: The following steel shall be hot-dip galvanized (including any associated fasteners):
 - 1. Lintels and shelf angles attached to structural-steel frame and located in exterior walls.
 - 2. Railing exposed to weather.

2.9 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Design of temporary bracing and supports shall be the responsibility of the Contractor. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings," unless closer tolerances are required for proper fitting of adjoining or enclosing materials, in which case the more stringent shall apply.
- B. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base plates. Clean bottom surface of base plates.
 - 1. Set base plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and base plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
 - 5. Grout under baseplates in accordance with Section 03300.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges," Unless adjoining materials dictate a tighter tolerance.
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated. Any member having a splice not shown and detailed on the accepted shop drawings shall be rejected.
- F. Do not field cut or alter structural members without approval of Architect/Engineer. Do not use thermal cutting during erection.
- G. Gas Cutting: Do not use gas cutting torches in the field to correct fabrication errors in structural framing.

- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- J. Slide Bearings: Slide bearing plates shall be permanently affixed to the member and support by welding. Member faces shall be aligned and leveled so as to maintain contact between surfaces before installing bearing plates.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
 - 2. A307 bolts and high-strength (A325 and A490) bolts noted to be "snug-tight" shall be tightened using a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench, bringing the plies into contact.
 - 3. High-strength bolts which are not specifically designated to be "snug-tight" shall be tightened to provide at least the minimum tension shown in Table 4 of the "Specification for Structural Joints using ASTM A325 and A490 Bolts." Tightening shall be done by the turn-of-the-nut method, with direct tension indicators, or by properly calibrated wrenches.
 - 4. Bolts tightened with a calibrated wrench or by torque control shall have a hardened washer under the element (nut or bolt head) turned in tightening.
 - 5. Hardened washers shall be placed over slotted holes in an outer ply. Hardened beveled washers shall be used where the outer face of the bolted parts has a slope greater than 1:20 with respect to the bolt axis.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work. Welds not specified shall be continuous fillet welds designed to develop the full strength of the member. A combination of welds and bolts shall not be used to transmit stress at the same face of any connections. Clean completed welds prior to inspection. Slag shall be removed from all completed welds.
 - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 - 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds.
- B. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 - 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touch-up Cold Galvanizing: Touch up areas of hot dip galvanized members where galvanizing has been abraded during shipping and erection and areas where galvanizing has been removed or damaged due to welding. Apply cold galvanizing compound in accordance with the manufacturer's instructions to a minimum dry film thickness of 2.0 mils.
- C. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, and abutting structural steel.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION 05 12 00

SECTION 05 21 00

STEEL JOISTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish all labor and materials required to fabricate, deliver, and erect steel joists and joist girders, including all bridging, ceiling extensions, bearing plates, side wall anchors, and extended ends.
- B. This Section includes the following:
 - 1. Long-span steel joists.
- C. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for installing bearing plates in concrete.

1.3 DEFINITIONS

- A. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
- B. Design special joists to withstand design loads with live load deflections no greater than the following:
 - 1. Roof Joists: Vertical deflection of 1/360 of the span.

1.5 SUBMITTALS

- A. Submit in accordance with Division 1 Section "Submittals."
- B. Submittals for Review:

1. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, camber, coatings, material properties, configuration, joist accessories; splice and connection locations and details; and attachments to other construction.

C. Submittals for Information:

1. Design calculations for all joists for which the standard load tables are not applicable. Submit prior to, or with the shop drawings. Calculations shall bear the seal of a Registered Professional Engineer, licensed in the State of Texas. Shop drawings submitted without corresponding calculations will be returned unchecked as an incomplete submittal. Calculations will be retained for the Architect's file and will not be approved or returned.
2. Welders Certificates: Submit certificates to Owner's Testing Laboratory, certifying that welders to be employed on the project have passed AWS qualification tests within the previous 12 months. If recertification of welders is required, recertification shall be contractor's responsibility.
3. Product Data: For each type of joist, accessory, and product indicated.
 - a. Indicate locations and details of bearing plates to be embedded in other construction.
4. Manufacturer Certificates: Signed by manufacturers certifying that joists comply with requirements.
5. Mill Certificates: Signed by bolt manufacturers certifying that bolts comply with requirements.
6. Field quality-control test and inspection reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists, including headers and other supplemental framing, complying with applicable standard specifications and load tables of SJI "Specifications." Manufacturer shall have a minimum of five years documented experience in the design and fabrication of open-web joists and joist girders
 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into cast-in-place concrete and/or masonry construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
- C. Structural Steel For Supplementary Framing and Joist Leg Extensions: ASTM A36, minimum
- D. Steel Bearing Plates: ASTM A 36/A 36M.
- E. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A, carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.⁷
 - 1. Finish: Plain, uncoated.
- F. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Plain.
- G. Welding Electrodes: Comply with AWS standards.

2.2 PRIMERS

- A. Primer: SSPC-Paint 15, Type 1 red oxide , or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.3 LONG-SPAN STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as follows:
 - 1. Joist Type: LH-series steel joists and DLH-series steel joists.
 - 2. End Arrangement: Underslung.
 - 3. Top-Chord Arrangement: As indicated.
- B. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work. Refer to Section 2.7 C. for additional welding requirements.

- C. Camber long-span steel joists according to SJI's "Specifications." Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.4 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
- C. Steel bearing plates with integral anchorages are specified in Division 5 Section "Metal Fabrications."
- D. Supply ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface, unless otherwise indicated.
- E. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

2.5 FABRICATION

- A. Splices: Shop splices may occur in chord or web members. Members containing a butt weld splice shall develop an ultimate tensile force of at least 57,000 psi times the full design area of the chord or web.
- B. Holes shall not be made or enlarged by burning with a torch.
- C. Welds shall meet the following criteria for acceptance:
 - 1. Remove slag from welds prior to inspection.
 - 2. Cracked welds are not acceptable and must be repaired.
 - 3. Thorough fusion shall exist between the weld and base metal, as determined by visual inspection.
 - 4. Unfilled weld craters shall not be included in the design length of the weld.
 - 5. Undercut shall not exceed 1/16" provided that it is oriented parallel to the principal stress.
 - 6. The sum of surface (piping) porosity diameters shall not exceed 1/16" in any 1" of design weld length.
 - 7. Weld spatter that does not interfere with paint coverage is acceptable.

2.6 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Apply 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Minimum bearings and anchorage shall conform to referenced SJI standards and the Drawings.
 - 4. Allow for erection loads. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction. Construction loads shall not be applied until joists are permanently fastened to supports and all bridging has been installed.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using ASTM A 307 carbon-steel bolts.
- E. Bridging shall conform to SJI standards and the shop drawings. Provide and install extra bridging, where indicated or where required due to loading, in addition to the minimum SJI requirements. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.
- B. Field welds will be visually inspected according to AWS D1.1/D1.1M.
- C. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
 - 1. Radiographic Testing: ASTM E 94.
 - 2. Magnetic Particle Inspection: ASTM E 709.
 - 3. Ultrasonic Testing: ASTM E 164.

4. Liquid Penetrant Inspection: ASTM E 165.

- D. Bolted connections will be visually inspected.
- E. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
- F. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
- G. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.4 REPAIRS AND PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 21 00

SECTION 05 31 00

STEEL DECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Roof deck.
- 2. Composite floor deck.

- B. Work Included

- 1. Furnish all labor and materials required to fabricate, deliver and install steel roof deck and accessories including formed steel cant strips, eave strips, valley strips, sump pans, edge closures, pour stops, reinforcing plates and related accessories.
- 2. Furnish all labor and materials required to fabricate, deliver and install steel floor deck and accessories including formed steel end closures, edge forms, flashings, and reinforcing plates, headed shear studs, and related accessories.

- C. Related Sections include the following:

- 1. Division 3 Section "Cast-in-Place Concrete" for structural concrete fill over steel deck.
- 2. Division 5 Section "Structural Steel" for shop- and field-welded shear connectors.
- 3. Division 5 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
- 4. Division 9 painting Sections for repair painting of primed deck.

1.3 SUBMITTALS

- A. Submittals for Review:

- 1. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
- 2. Product Data: For each type of deck, accessory, and product indicated. Provide deck dimensions, sectional properties, uplift resistance and diaphragm capacity for specified fastener layout and support spacing, and finishes.

- B. Submittals for Information:

- 1. Product Certificates: For each type of steel deck, signed by product manufacturer. Certify that products comply with SDI, UL and ICBO standards as specified.

2. Manufacturer's installation instructions.
3. Welding certificates: For each welder employed on the Work.
4. Field quality-control test and inspection reports.
5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
 - a. Power-actuated mechanical fasteners.
 - b. Acoustical roof deck.
6. ICBO Research/Evaluation Reports: Deck units shall be approved by the International Conference of Building Officials and shall have a corresponding report from ICBO
7. Deck units shall be classified by Underwriter's Laboratory, Inc. and shall be labeled and marked as required by UL, indicating manufacturer testing and inspection.

1.4 QUALITY ASSURANCE

- A. Installer: Company specializing in performing the work of this Section with minimum 5 years documented experience.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
- D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- E. Comply with applicable provisions of the following specifications and documents.
 1. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
 2. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.
 3. SDI (Steel Deck Institute) - Design Manual for Composite Decks, Form Decks, Roof Decks.
 4. SSPC (Steel Structures Painting Council) - Painting Manual.
 5. UL - Fire Resistance Directory.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
 - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Deck:
 - a. ASC Profiles, Inc.
 - b. Canam Steel Corp.;The Canam Manac Group.
 - c. Consolidated Systems, Inc.
 - d. DACS, Inc.
 - e. D-Mac Industries Inc.
 - f. Epic Metals Corporation.
 - g. Marlyn Steel Decks, Inc.
 - h. New Millennium Building Systems, LLC.
 - i. Nucor Corp.; Vulcraft Division.
 - j. Roof Deck, Inc.
 - k. United Steel Deck, Inc.
 - l. Valley Joist; Division of EBSCO Industries, Inc.
 - m. Verco Manufacturing Co.
 - n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.2 ROOF DECK

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 or 40, G60 zinc coating.
 - 2. Deck Profile: As indicated
 - 3. Profile Depth: As indicated
 - 4. Design Uncoated-Steel Thickness: As indicated.
 - 5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
 - 6. Span Condition: As indicated.
 - 7. Side Laps: Overlapped.

2.3 COMPOSITE FLOOR DECK

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. Composite Steel Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 30, with the minimum section properties indicated, and with the following:
 - 1. Galvanized Steel Sheet: ASTM A 653/A, Structural Steel (SS), Grade 33, G30 zinc coating.
 - 2. Profile Depth: As indicated.
 - 3. Design Uncoated-Steel Thickness: As indicated.
 - 4. Span Condition: As indicated.

2.4 ACCESSORIES

- A. Any iron or steel product produced through a manufacturing process shall be produced in the United States.
- B. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- C. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
 - 1. Mechanical Fasteners: Galvanized hardened steel, self tapping "Teks" screws, manufactured by Illinois Tool Works, Inc., Buildex Division, or equal. Size shall be #10 minimum, unless noted otherwise.
 - 2. Powder Actuated Fasteners: Zinc coated fastener with .145 inch shank diameter and 1 1/4 inch shank length. X-DNI pin as manufacturer by Hilti, or equal.
- D. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- E. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- F. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.
- H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- I. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and sloped recessed pans of 1-1/2-inch minimum depth, sealed watertight. For drains, cut holes in the field.

- J. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, sealed watertight. For drains, cut holes in the field.
- K. Galvanizing Repair Paint: ASTM A 780.
- L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.
- B. Locate deck bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

- A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
 - 1. Weld Diameter: As indicated.

2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches, and as follows:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
 2. Fasten with a minimum of 1-1/2-inch-long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
1. End Joints: Lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space connections not more than 12 inches apart with at least one connection at each corner.
1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.
- G. Architectural finishes and mechanical, electrical, and plumbing equipment shall not be hung directly from the metal deck.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.5 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 31 00

SECTION 054000

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section includes:

- 1. **Steel studs, slotted channels, joists, and purlin framing, usually of 16 to 20 gauge, including bracing, fasteners and accessories.**

1.3 SYSTEM REQUIREMENTS

A. Design Requirements:

- 1. **Fabricator is responsible for designing framing system**, including anchorage to structural system and necessary modifications to meet specified requirements and maintain visual design concepts. Design system in accordance with A.I.S.I. Design Manual.
- 2. **Employ registered professional engineer**, licensed to practice structural engineering in jurisdiction where Project is located, to engineer each component of steel stud framing system.
- 3. **Size components to withstand following design loads:**
 - a. Internal: 5 lbf/ft, minimum.
 - b. External: 20 lbf/ft, minimum or as otherwise required to meet building code requirements.
- 4. **Maximum allowable deflection:**
 - a. Supporting masonry veneer: 1/600 of span.
 - b. Unless noted otherwise: 1/360 of span.

B. Performance Requirements:

- 1. Fabricate and assemble system to provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
- 2. Fabricate and assemble system to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

C. Interface With Adjacent Systems:

- 1. Integrate design and connections with adjacent construction.
- 2. Accommodate allowable tolerances and deflections of structural members in installation.

1.4 SUBMITTALS

A. General: Submit in accordance with Section 013300.

B. Product Data:

- 1. Submit product data for framing members, accessories, and connection devices.
- 2. Describe materials, finish and section properties.

C. Sustainable Design Submittals:

- 1. LEED v4 Submittals:
 - a. MR Credit: Building Product Disclosure and Optimization - Environmental Product Declarations: Provide Type III EPDs from manufacturers that have third-party verified environmental impact data.
 - b. MR Credit: Building Product Disclosure and Optimization - Sourcing of Raw Materials: Provide recycled content of products showing the percentage of postconsumer and/or preconsumer recycled content by weight and its associated cost.
 - c. MR Credit: Building Product Disclosure and Optimization - Material Ingredients:

Provide Health Product Declarations (HPDs) from manufacturers with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.

- d. **MR Credit: Construction and Demolition Waste Management:** Include a statement indicating percentage of materials diverted from disposal in landfills and incinerators, and where recyclable resources are directed back to the manufacturing process.
 - D. **Shop Drawings:** [Provide shop drawings prepared by cold-formed metal framing manufacturer.]
 1. Plans, elevations, sections and details indicating component locations, connections between components, connections of components to structure.
 2. Connection details indicating size, locations, and spacings of fasteners and welds.
 3. Accessory installation details.
 4. **Complete design calculations certified by a licensed professional engineer in the State of Texas** for cold-formed metal framing members and member connections to each other and to the structure. Architect/Engineer will review calculations for information only. Architect will not review calculations for accuracy, nor assume responsibility for adequacy of calculations.
 - E. **Submit following Informational Submittals:**
 1. Qualification Data: Manufacturer's, erector's, and welder's qualification data.
 2. Certifications specified in Quality Assurance article of this Section.
 3. **Evaluation Reports: For cold-formed steel framing.**
 - a. Metal stud manufacturer to have a third party evaluation report for its products that are reviewed to the local building code or its model code (IBC 2009 and AISI S100 or IBC 2012 and AISI S100 or IBC 2015 and AISI S100).
- 1.5 **QUALITY ASSURANCE**
- A. **Engineer Qualifications:** Registered professional engineer licensed to practice structural engineering in jurisdiction where Project is located.
 - B. **Erector Qualifications: Minimum of 10 years documented experience on comparable steel stud framing projects.**
 - C. **Welder Qualifications: AWS certified within past 12 months for each type of weld required.**
 - D. **Certifications:**
 1. Submit certificates verifying AWS qualifications for each welder employed on Project.
 2. Submit fabricator's certification that products furnished for Project meet or exceed specified requirements.
 3. Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association (SFIA) or similar organization.
 - E. **Manufacturer Qualifications:** Member in good standing of the Steel Framing Industry Association (SFIA) or be a part of a similar organization that provides verifiable code compliance program.
 1. Products to be certified under an independent third party inspection program administered by an agency accredited by IAS to ICC-ES AC98 IAS Accreditation Criteria for Inspection Agencies.
 - F. **Product Tests:** Mill certificates or data from a qualified independent testing agency[, **or in-house testing with calibrated test equipment,**] indicating steel sheet complies with requirements, including base-steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
 - G. **Comply with AISI Specifications and Standards.**
 1. AISI S100 "North American Specification for the Design of Cold-Formed Steel Structural Members".
 2. AISI S200 "North American Standard for Cold-Formed Steel Framing – General Provisions".
- 1.6 **DELIVERY, STORAGE, AND HANDLING**
- A. Comply with requirements of Section 016000.
 - B. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling as required in AISI's "Code of Standard Practice".

1.7 **PROJECT CONDITIONS**

- A. Field verify measurements. Architect will not review or take responsibility for dimensions.

PART 2 - PRODUCTS

2.1 **ACCEPTABLE MANUFACTURERS**

- A. **Basis of Design:** ClarkDietrich Building Systems
B. **Manufacturers:**
1. ClarkDietrich Building Systems.
2. Consolidated Fabricators Corp.
3. Custom Stud, Inc.
4. MarinoWARE.
5. United Metal Products, Inc.

2.2 **MATERIALS**

- A. **Framing Members, General:** Comply with ASTM C 955 for conditions indicated.
B. **Steel Sheet:** ASTM A 1003, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: **As required by structural performance.**
2. Coating: **G90.**
C. **Steel Sheet for Vertical Deflection Clips:** ASTM A 1003, ASTM A 653, structural steel, zinc coated, of grade and coating as follows:
1. Grade: **As required by structural performance.**
2. Coating: **G90.**
D. **Studs:**
1. C-shape design, roll formed with punched web, 1-3/8 inch minimum face flange and manufacturer's standard return lip.
a. Product: ClarkDietrich Building Systems; C-shaped steel studs (CWN).
2. **Galvanized studs:**
a. **16 gauge and thicker:** Grade as required by design, but not less than ASTM A653.
E. **Steel Ceiling Joists:** Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with enlarged service holes, with stiffened flanges.
1. Product: ClarkDietrich Building Systems; C-shaped steel sections, or comparable product.
F. **Runners:**
1. Channel shaped; same width as studs, tight fit; solid web.
2. Galvanized: ASTM A653.
3. Sheet Metal Thickness: Minimum thickness to match studs.
G. **Headers and Jambs - Heavy-Duty Stud:** Manufacturer's proprietary shape used to form header beams and jambs, columns or posts, of web depths indicated, unpunched, with stiffened flanges and as follows:
1. Product: ClarkDietrich Building Systems; Heavy Duty Stud (HDS) and Header Bracket (HDSC) or RedHeader PRO.
2. Minimum Base-Steel Thickness: **Matching steel studs.**
H. **Vertical Deflection Clips:** Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. Product: ClarkDietrich Building Systems; FCSC, FCEC, FTSC, FTC3, FTC5, FS12, FS15, or FS24.
I. **Slotted Deflection Track:** Manufacturer's single, deep-leg, U-shaped steel track; punched with vertical slots in both legs. Studs should be positively attached to deep-leg track using vertical slots while allowing free vertical movement. Legs designed to support horizontal and lateral loads and transfer them to the primary structure, as follows:
1. Product: ClarkDietrich Building Systems; MaxTrak Slotted Deflection Track.
J. **U-Channel Assembly:** Manufacturer's standard length U-Channel for lateral bracing for exterior

Comment [GB1]: *We recommend G90 coating on clips.

Comment [GB2]: NOTE: A446 has been withdrawn and replaced by A653.

Comment [GB3]: *Labor savings product.

- curtain wall framing, loadbearing walls, or high interior partitions constructed of structural studs.
1. Product: ClarkDietrich Building Systems; U-Channel and FastBridge Clip FB68.
- K. **Accessories, Plates, Gussets, Clips:** Formed sheet steel, thickness determined for conditions encountered; same finish as framing members.
1. Bracing, bridging, and solid blocking.
 - a. Product: ClarkDietrich Building Systems; Spazzer 5400 Bridging Bar (SPZS) or Spazzer Bar Guard (SPBG).
 2. Web stiffeners.
 - a. Product: ClarkDietrich Building Systems; QTWS.
 3. Anchor clips.
 - a. Product: ClarkDietrich Building Systems; Moment Clip (MC Series) or Holdown (CD Series).
- L. **Structural Steel Shapes:** Comply with Division 05 structural Sections. Size as required by design for conditions encountered as indicated on Drawings.
- M. **Fasteners:**
1. Self-drilling, self-tapping screws, bolts, nuts and washers: Size, type and spacing determined to suit Project conditions; ASTM A153, hot-dip galvanized, Class C or D as appropriate.
 2. Anchorage Devices: Power driven or powder actuated as appropriate for material connected.
 3. Welding: In conformance with AWS D1.3.
- N. **Galvanizing Touch-Up Paint:** FS TT-P-641, zinc oxide type.
- O. **Slip Track for Head Conditions:**
1. Ceiling runner designed to allow head-of-wall to compress or extend with movement of structure above while maintaining the fire-rating of the wall assembly by a factory applied cured intumescent fire stop material affixed to steel profile. Comply with requirements of ASTM C 645, of thickness indicated for studs and of width to accommodate depth of studs indicated. The fire-rated assembly shall be capable of unencumbered movement as required and indicated on the drawings. The assemblies shall have been tested in accordance with UL 2079, ASTM E 1966, and ASTM E814.
 2. **Basis of Design:** BlazeFrame Industries; BlazeFrame; make and model to fit conditions.
- 2.3 **FABRICATION**
- A. Fit and assemble in largest practical sections for delivery to site, ready for installation.
 - B. Fabricate in accordance with requirements of ASTM C955.
 - C. Cut framing components squarely for attachment to perpendicular members, or as required for angular fit against abutting members. Hold members positively in place until properly fastened.
 - D. Fabricate studs of sizes and sheet metal thicknesses as required by design indicated on Drawings.
- 2.4 **ROOF RAFTER FRAMING**
- A. **Steel Rafters:** Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, complying with ASTM C 955, and as follows:
 1. Product: ClarkDietrich Building Systems; C-shaped steel sections, or comparable product.
 2. Minimum Uncoated-Steel Thickness: 0.0538 inch.
 3. Flange Width: 1-5/8 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 014300.

3.2 ERECTION OF STUDDING

- A. Install cold-formed steel framing in accordance with ASTM C 1007 and AISI S200 "North American

Standard for Cold-Formed Steel Framing – General Provisions,” and manufacturer's written instructions unless more stringent requirements are indicated.

- B. Install components in accordance with manufacturer's printed instructions. Provide temporary bracing until erection is complete.
- C. Connect to supports using fastener or welding method.
- D. Locate and align floor and ceiling runners according to layout on approved shop drawings. Anchor in place per engineered Shop Drawings and at maximum 24 inch centers. Locate runner end joints between studs. Splice with length of stud cut to fit stud-to-stud. Anchor splice to each runner at ends and at each end of splice stud. Coordinate installation of required sealants with runner installation.
- E. Install studs plumb, level, and square, free from warp or twist while maintaining dimensional tolerances and alignment with adjacent surfaces.
- F. **Place studs at uniform spacing shown on engineered shop drawings, but not more than 16 inches on center maximum** with full bearing against inside web of runners. Align with all flanges facing same direction.
- G. **Locate studs not more than 2 inches from abutting walls.**
- H. Secure studs to runners on both sides, top and bottom with fasteners or welding of type and at spacing shown on approved shop drawings. Do not attach studs to top runner at slip track locations. Provide deflection allowance in top runners according to cold formed metal manufacturer's requirements for non-load-bearing studs.
- I. **Construct corners using minimum 3 studs. Provide double studs at wall openings, and at door and window jambs.**
- J. Erect studs in one piece full length, brace, and reinforce to develop full strength to meet design requirements. Splicing of studs is not permitted, unless method of splicing is indicated on approved shop drawings.
- K. Place insulation in multiple stud spaces made inaccessible after erection.
- L. Install intermediate jack studs (cripples) above and below openings to match wall stud spacing.
- M. Brace studs that support fixtures, mechanical and electrical items with stud sections or channel bridging as required by design to support applied loads without excess deflection or stress. Install additional framing members as required for attachment of fixtures.
- N. Attach **bridging** as called for by Engineer and in manner to prevent stud rotation. Provide bridging at following locations at a minimum and elsewhere as required by design:
 - 1. **For non-loadbearing exterior walls:**
 - a. Walls less than 10'-0" in height: 1 row mid-height of wall.
 - b. Walls greater than 10'-0" in height: Maximum 5 feet on center.
 - 2. **For load bearing exterior walls:**
 - a. Walls less than 10'-0" in height: 2 rows equally spaced.
 - 3. **Walls greater than 10'-0" in height:** Maximum 4'-0" on center.

3.3 ERECTION OF JOISTS

- A. Install framing components in accordance with manufacturer's instructions.
- B. Make provisions for erection stresses. Provide temporary alignment and bracing.
- C. Place joists at spacing as indicated on drawings, not more than 2 inches from abutting walls.
- D. Connect joists to supports using fastener or welding method.
- E. Set floor joists parallel and level, with lateral bracing and bridging.
- F. **Locate joist end bearing directly over load bearing studs** or provide load distributing member to top of stud track.
- G. Provide joist web stiffeners at reaction points.
- H. Touch-up field welds and damaged galvanized surfaces with primer.
- I. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. **Bridging:** Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

3.4 **TOLERANCES**

- A. Maximum variation from true position: 1/4 inch.
- B. Maximum variation of any member from plane: 1/8 inch in 4'-0", non-cumulative.

3.5 **FIELD QUALITY CONTROL**

- A. **Testing Agency: Retain a qualified independent testing agency to perform field quality-control testing.**
- B. **Field and shop welds shall be inspected and tested. Request frequency from Architect if not indicated on Drawings.**
- C. Testing agency will report test results promptly and in writing to Contractor, Architect and Structural Engineer.
- D. Remove and replace Work that does not comply with specified requirements.
- E. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.6 **ADJUSTING**

- A. Touch-up field welds and damaged galvanized surfaces with appropriate primer.

END OF SECTION

SECTION 055000

METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for operable partitions.
2. Steel framing and supports for countertops.
3. Steel framing for partial height walls.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Steel shapes for cast stone trim pieces.
7. Elevator machine beams and hoistway beams.
8. Steel shapes for supporting elevator door sills.
9. Shelf angles.
10. Metal ladders.
11. Metal ships' ladders.
12. Metal bollards.
13. Miscellaneous metal shapes.
14. Loose bearing and leveling plates for applications where they are not specified in other Sections.
15. Metal walkway planks and catwalks.
16. Miscellaneous steel applications as required.

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

1. **Masonry Support:** Loose steel lintels; steel blocking, steel rods, and inserts.
2. **Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.**

C. Related Sections:

1. Section 055133 - Metal Ladders.

1.3 PERFORMANCE REQUIREMENTS

- A. **Delegated Design:** Design ladders, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Metal nosings and treads.
3. Paint products.
4. Grout.

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

1. Include plans, elevations, sections, and details of all metal fabrications and their connections. Show anchorage and accessory items.
2. **Shop Drawings shall be prepared by reputable individuals and firms within the Continental United States.**

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

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

PART 2 – PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without any seam marks, roller marks, rolled trade names, or blemishes whatsoever.

2.2 FERROUS METALS

- A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Steel Pipe: ASTM A 53, standard weight (Schedule 40) unless otherwise indicated.
- D. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches.
 - 2. Material: Galvanized steel, ASTM A 653, commercial steel, Type B, with G90coating; 0.079-inch nominal thickness.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. **Provide stainless-steel fasteners for fastening aluminum.**
- B. **Steel Bolts and Nuts:** Regular hexagon-head bolts, ASTM A 307, Grade A ASTM F 568M, Property Class 4.6; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. **Stainless-Steel Bolts and Nuts:** Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.
- D. **Anchor Bolts:** ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. **Eyebolts:** ASTM A 489.
- F. **Machine Screws:** ASME B18.6).
- G. **Lag Screws:** ASME B18.2.
- H. **Wood Screws:** Flat head, ASME B18.6.1.
- I. Plain Washers: Round, ASME B18.22.
- J. Lock Washers: Helical, spring type, ASME B18.21.
- K. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

- L. Cast-in-Place Anchors in Concrete:** Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- M. Post-Installed Anchors: Chemical anchors.**
 - 1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes:** Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer:** Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
- C. Galvanizing Repair Paint:** High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint:** Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Non-shrink, Metallic Grout:** Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- F. Non-shrink, Nonmetallic Grout:** Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

- A. Shop Assembly:** Pre-assemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals** cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32-inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners** to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work** with accurate angles and surfaces and straight edges.
- E. Weld corners and seams** continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections** with hairline joints, flush and smooth, using concealed fasteners or welds unless noted otherwise on Drawings. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections** that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications** as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage** of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
 - 1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
- C. **Operable Partitions:** Fabricate supports for operable partitions from continuous steel beams of sizes recommended by partition manufacturer or, if none provided, as required by structural engineer with attached bearing plates, anchors, and braces as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

2.7 SHELF ANGLES

- A. **Fabricate shelf angles from steel angles of sizes indicated or, if none shown, as required by specific application,** and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch-bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
 - 1. Provide mitered and welded units at corners.
 - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
 - 3. **Provide continuous shelf angle as required for masonry at floor slab edge below 30' in height of masonry.**
 - 4. Provide continuous shelf angle at each floor slab edge above 30' above first floor slab.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. **Galvanize shelf angles located in exterior walls.**
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.
- E. **Location: On buildings over 2 stories tall or where brick height exceeds 30 foot from brick ledge height, provide continuous brick shelf angles attached to building structure of size as required to support brick at each floor slab level above 30' AFF.**

2.8 METAL LADDERS

- A. **General:**
 - 1. Comply with ANSI A14.3 unless otherwise indicated.
 - 2. For elevator pit ladders, comply with ASME A17.1.
 - 3. Coordinate location with elevator manufacturer.
- B. **Steel Ladders:**
 - 1. Space siderails 18 inches apart unless otherwise indicated.
 - 2. **Siderails:** Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
 - 3. **Rungs:** 3/4-inch diameter steel bars. Vertical spacing to be 12 inches o.c. maximum.
 - 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 5. Provide nonslip surfaces on top of each rung by coating with abrasive material metallurgically bonded to rung.
 - 6. Provide platforms as indicated or as otherwise required fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 3/4 inch in least dimension.
 - 7. Support each ladder at top and bottom and not more than 60 inches with welded or bolted steel brackets.
 - 8. Include adjustable stringer extension to serve as extended railing at top of ladder.
 - 9. Galvanize exterior ladders, including brackets and fasteners.
 - 10. Prime ladders, including brackets and fasteners, with zinc rich primer.
- C. **Elevator Pit Ladders:**
 - 1. **Confirm final design requirements with elevator manufacturer prior to fabrication.**

2. Provide one ladder per elevator pit or as otherwise required by manufacturer or state elevator code.
3. Space siderails of elevator pit ladders 16 inches apart.
4. **Siderails:** Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
5. **Rungs:** 3/4-inch-diameter steel bars. Vertical spacing to be 12 inches o.c. maximum.
6. Extend ladder 48" min above sill of the access door.
7. **Standoff:** 4-1/2" from centerline of rung to wall behind ladder.
8. Provide non-slip surfaces on top of each rung by coating with abrasive material metallicity bonded to rung.
9. The ladder and its attachments shall be capable of sustaining a load of 350 lbs.
10. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets
11. Shop prime ladders, including brackets

2.9 METAL SHIPS' LADDER

- A. **Provide metal ships' ladders where indicated on the Drawings.** Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation. Channels at 68 degrees from horizontal.
 1. Treads shall be not less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height shall be not more than 9-1/2 inches.
 2. Fabricate ships' ladders, including railings from steel.
 3. Fabricate treads from rolled-steel floor plate.
 4. Include adjustable railing extension pole at top of ships' ladder for use when roof hatch is open.
- B. Prime steel ships' ladders, including treads, railings, brackets, and fasteners.
- C. Basis of Design: FSI Industries; FTHASL24184.

2.10 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe.
- B. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch- thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- C. Prime bollards with zinc-rich primer.

2.11 METAL WALKWAY PLANKS AND CATWALKS

- A. **Basis of Design:**
 1. McNichols; Plank Grating; 8 diamond, 2" channel; GRIP STRUT; capable of spanning 48" o.c.; plain steel.
 2. MarCo Specialty Steel, Inc.; Grip-Trac Diamond Safety Grating.
- B. **Provide stringers, miscellaneous steel framing as required by 3rd party design engineer.**

2.12 LOOSE BEARING AND LEVELING PLATES

- A. **Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction as indicated on Drawings or as otherwise required.** Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.13 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. **Galvanize loose steel lintels located in exterior walls.**

- C. **Provide steel lintels of sizes and shapes as required whether or not called for in the Drawings.**

2.14 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove all tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

- A. **Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153 for steel and iron hardware and with ASTM A 123 for other steel and iron products.**
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. **Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.**
 - 1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. **Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:**
 - 1. **Cast Aluminum:** Heavy coat of bituminous paint.
 - 2. **Extruded Aluminum:** Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

3.3 INSTALLING METAL BOLLARDS

- A. Fill bollards solidly with concrete and allow concrete to cure seven days before installing.

- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with non-shrink, non-metallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.
- C. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 **INSTALLING BEARING AND LEVELING PLATES**

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use non-shrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use non-shrink, nonmetallic grout in exposed locations unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 **ADJUSTING AND CLEANING**

- A. **Touchup Painting:** Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. **Apply by spray** to provide a minimum 2.0-mil dry film thickness.
- B. **Galvanized Surfaces:** Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.6 **SCHEDULE**

- A. **Provide and install items listed in the Schedule below, called for in other portions of this section, and shown on Drawings with anchorage and attachments necessary for installation.**
- B. **The Schedule is a list of principal items only. Refer to Drawing details for additional items not specifically scheduled below.**
- C. **Items of Work Custom Fabricated:**
 - 1. **Lintels, ledges, and channels and plates** not attached to structural framing, for support of metal decking and masonry.
 - a. Provide curved, arched, and straight shapes: **Provide as required whether or not shown on Drawings.**
 - b. **Finish:** Galvanized.
 - 2. **Miscellaneous Steel Shapes:** Channels, angles, plates, tubing, connections, and bolts where shown and detailed on Drawings. **Provide as required whether or not shown on Drawings.**
 - 3. **Structural Bracing:** To support shading canopies, ladders, toilet partitions, TV brackets, projector supports, projections screens, movable partitions, and other equipment. **Provide as required whether or not shown on Drawings.**
 - 4. **Elevator Hoistway Beams and Sill Supports:** Provide as required by elevator manufacturer and as otherwise required **whether or not shown on the Drawings.**
 - 5. **Movable Partition Supporting Structure:** Provide structural beams and supporting structure as required by structural engineer **whether or not shown on the Drawings.**
 - 6. **Bollards at Dumpster Enclosures:** Install two 6 inch diameter concrete filled bollards to 48" above finished paving behind each dumpster. Locate 12" in from perimeter edges of each dumpster.
 - 7. **Steel Channel Framing at Restroom Lavatory Countertops:** Provide steel channel framing at front and rear of lavatory countertops and 2" by 2" tube steel columns vertical supports in walls at all public restrooms and as otherwise indicated on the Drawings or, if none shown, as required by Architect.

8. **Shelf Angles:** Provide continuous shelf angles at second floor slab and at each floor slab above second floor as indicated on the Drawings or, if none shown, as required by Architect and Structural Engineer.
9. **Pony Wall Structure (Dental Hygiene at other locations as required):** Where walls do not extend above ceiling, construct walls with 3-1/2" steel channels at 48" o.c. with top and bottom steel channel rails. Weld all connections solid and expansion bolt to floor or as otherwise approved by structural engineer. When completed, wall shall resist 250 lb. overturning force applied perpendicular to vertical axis of wall. Infill between channels with cold formed, heavy gauge, metal studs at 16" o.c.

END OF SECTION

SECTION 055100

METAL STAIRS

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 **SECTION INCLUDES**
 - A. **Steel stair frame of structural sections, cast-in- place 3-inch thick concrete stair treads with closed risers, and landings at fire and communicating stairs.**
- 1.3 STRUCTURAL REQUIREMENTS
 - A. **Fabricate stair assembly to support live load in order to meet building code requirements. In the event building code has no such requirement, fabricate to support 100 lbs/S.F. uniform live load and 300 lbs/S.F. at most critical point of tread. Maximum deflection L/360.**
- 1.4 QUALITY ASSURANCE
 - A. Design and construct stairs in accordance with AISC Specifications and NAAMM standards.
- 1.5 SUBMITTALS
 - A. **Submit shop drawings** under provisions of Section 013300.
 - B. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, openings, size, and type of fasteners, and accessories.
 - C. Include erection drawings, elevations, and details where applicable.
 - D. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.
 - E. **Complete design calculations certified by a registered professional engineer in the State of Texas for stair members and member connections to each other and to the structure. Architect will review calculations for information only. Architect will not review calculations for accuracy, nor assume responsibility for adequacy of calculations.**
- 1.6 DELIVERY, STORAGE AND HANDLING
 - A. Deliver, store, handle, and protect products in accordance with Section 016000.
 - B. Store materials off the ground on blocking or skids.

PART 2 - PRODUCTS

- 2.1 MATERIALS
 - A. Steel Section: ASTM A36.
 - B. Steel Tubing: ASTM A500, Grade B.
 - C. Sheet Steel: ASTM A570, or A366, grades as required for loads imposed.
 - D. Bolts, Nuts, and Washers: ASTM A307.
 - E. Welding Materials: AWS D1.1; type required for materials being welded.
 - F. Primer: FS TT-P-86G type I or II for shop application and field touch-up. Verify compatibility of selected product with intended surface finish prior to application.
 - G. Exposed Mechanical Fastenings: Screws or bolts; unobtrusively located; consistent with design of structure.
 - H. **Treads:**
 - 1. Concrete pan type typical for treads on interior fire stairs.
 - I. **Concrete for Landings:** Portland Cement Type I 2500 PSI, 28 day strength, 2 to 3 inch slump.

- J. **Landing Concrete Reinforcement:** Mesh type, 6 x 6, 10/10, unfinished, unless Fibermesh is approved by Owner.
- K. **Grout:** Refer to Structural Sections, or if none, request requirements from Architect.

2.2 FABRICATION - GENERAL

- A. Verify dimensions on site prior to shop fabrication.
- B. Fabricate items with joints tightly fitted and secured.
- C. Fit and shop assemble sections in largest practical sizes, for handling through building openings.
- D. Grind exposed welds flush and smooth with adjacent finished surface. Ease exposed edges to small uniform radius.
- E. Make exposed joints butt tight, flush, and hairline.
- F. Accurately form components required for anchorage of stairs and landings to each other and to building structure.

2.3 FABRICATION - STAIRS AND PAN LANDINGS

- A. Fabricate stairs with steel pan construction to receive concrete for treads and landings.
- B. Secure treads to stringers with clip angles, welded in place.
- C. Form stringers of rolled steel channels, depth as indicated.
- D. **Prime paint all steel components.**
- E. **Design stair structure, stringers, and landings such that cross beams do not extend below depth of perimeter channels/structure and stringers.**
- F. **Offset stair risers at landings such that center guardrail and handrail at switch back can make a smooth continuous or curved return without requiring a vertical jog in the railings.**

2.4 FINISH

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. **Do not prime surfaces where field welding is required.**
- C. Prime paint items specified with one coat of primer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.

3.2 PREPARATION

- A. **Clean and strip primed steel items to bare metal where site welding is required.**
- B. Supply items required to be cast into concrete with setting templates, to appropriate sections.

3.3 INSTALLATION

- A. **Erect stairs level and plumb, free from distortion or defects detrimental to appearance or performance.**
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Verify alignment with adjacent construction. Coordinate related work.
- D. Do not field cut or alter members.
- E. Field bolt and weld to match standard of shop bolting and welding. Hide bolts and screws whenever possible.
- F. Mechanically fasten joints butted tight, flush, and hairline. **Grind welds completely smooth and flush (no exceptions).** Do not allow slag, rises, or uneven transitions of any type on stairs or railings.
- G. Obtain Architect/Engineer and Owner approval prior to site cutting or making adjustments not scheduled.
- H. **After erection, prime welds, abrasions, and surfaces not shop primed.**

- I. Verify stairways are in compliance with OSHA prior to stair utilization.
- 3.4 ERECTION TOLERANCES
 - A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.
 - B. Maximum Offset From True Alignment: 1/4 inch.
 - C. **Maximum Offset within continuous handrails: None allowed.**
- 3.5 **FINISH**
 - A. Refer Section 099713 - Steel Coatings.
- 3.6 **SCHEDULE**
 - A. Provide at all fire stairs and at other locations indicated on Drawings.

END OF SECTION

SECTION 055213

PIPE AND TUBE RAILINGS

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 SECTION INCLUDES
 - A. **Interior steel tube handrails, balusters, and fittings at fire and communicating stairs (excludes base bid Lobby Stair and Atrium railings).**
 - B. **Exterior steel handrails and guardrails.**
- 1.3 DESIGN REQUIREMENTS
 - A. **Railing assembly, wall rails, and attachments to resist lateral force of 250 lbs at any point and a uniform load of 75 lbs/lf (or meet local code if greater) without damage or permanent set.**
- 1.4 SUBMITTALS
 - A. **Submit shop drawings and product data** under provisions of Section 013300.
 - B. Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work.
 - C. Submit manufacturer's installation instructions under provisions of Section 013300.
 - D. Submit samples under provisions of Section 013300.
 - E. **Submit one sample, 48 inches long, of each railing system with final finish applied for Architect's approval prior to fabrication of final railings.**
- 1.5 FIELD MEASUREMENTS
 - A. Verify that field measurements are as indicated on shop drawings.
- 1.6 DELIVERY, STORAGE AND HANDLING
 - A. Deliver, store, handle and protect products in accordance with section 016000 and 013100.
 - B. Store materials off the ground and in their original protective wrapping.

PART 2 - PRODUCTS

- 2.1 STEEL RAILING SYSTEM
 - A. **Rails and Posts:** ASTM A 53 or A 501 steel tubing; welded jointing; sizes and shapes as indicated.
 - B. **Mounting:** Brackets and flanges, with steel brackets for anchoring to wood framing.
 - C. **Primer:** FS TT-P-86-G, red; one coat.
- 2.2 ACCEPTABLE FABRICATORS
 - A. Fabricator with a **minimum of ten years' experience fabricating similar railing systems** for commercial projects, as approved by Architect. Submit qualifications for approval.
- 2.3 FABRICATION
 - A. Verify dimensions on site prior to shop fabrication.
 - B. Fit and shop assemble sections in largest practical sizes, for delivery to site and installation.
 - C. **Construct railings as indicated on Drawings, or, if none shown, provide standard 6 pipe horizontal railing system with 1-1/2-inch diameter pipe. Construct so that a 4-inch sphere cannot pass through railing system.**

- D. Supply components required for secure anchorage of handrails and railings.
- E. **Grind exposed welds completely smooth and flush with adjacent surfaces with no visible defects, rises, misalignments, slag, or deviations. Fuse without undercutting or overlapping. Thoroughly remove weld splatter.**
- F. **Make exposed joints butt tight, flush, and hairline.**
- G. Accurately form components required for **concealed anchorage** of railings to each other and to building structure.
- H. Form and assemble joints exposed to weather to exclude water.
- I. **Finish:**
 - 1. **Steel Handrails:** Provide hot-dip zinc coating in accordance with ASTM A153 for anchors. Final coating – 2-coat epoxy with clear top coat. Refer to Section 099713 – Special Coatings.
- J. **Non-Shrink Grout:**
 - 1. Premixed and packaged non-ferrous aggregate, non-staining, shrinkage-resistant, non-corrosive, non-gaseous complying with CRD C621, 34.5 MPa (5000 psi) minimum compressive strength.
 - 2. **Acceptable products** and manufacturers:
 - a. Euco-NS, Euclid Chemical Co., Cleveland, OH.
 - b. Supreme, Gifford Hill, Dallas, Texas.
 - c. Crystex, L&M Construction Chemicals, Omaha, NE.
 - d. SonogROUT 10K, Sonneborn Building Products, Minneapolis, MN.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Beginning of installation means erector accepts existing conditions.

3.2 PREPARATION

- A. Supply items to be cast into concrete and placed in partitions with erection drawings to appropriate Sections.
- B. Clean and strip primed steel items to bare metal where site welding is required.
- C. Set boots and receivers in concrete.

3.3 INSTALLATION

- A. Install in accordance with shop drawings and manufacturer's instructions.
- B. **Erect work square and level, free from any and all distortion or defects detrimental to appearance or performance.**
- C. Anchor handrailings to structure.
- D. Weld field connections and grind completely smooth to complete assembly. Touch-up welds with primer.
- E. Securely attach handrail brackets to walls and stairs. Solidly anchor to solid wood blocking in walls.
- F. Verify railings are in compliance with OSHA and all other governing codes prior to utilization.

3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.

3.5 FINISH

- A. **Refer Section 099713 – Steel Coatings.**

END OF SECTION

SECTION 057300

DECORATIVE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes:**

- 1. **Architectural interior stainless steel railings at Lobby Stair and Atrium.**

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. **Delegated Design:** Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. **Structural Capacities:** Handrails, guardrails, and their supports must be designed for 50 lbs per linear foot, applied in any direction at the top of the top rail, and a concentrated load of 200 lbs applied in any direction at any location along the top of the top rail
- C. **General:** In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. **Steel:** 72 percent of minimum yield strength.
 - 2. **Stainless Steel:** 60 percent of minimum yield strength.
 - 3. **Glass:** 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
- D. **Thermal Movements:** Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. **Temperature Change:** 120 deg F, ambient; 180 deg F, material surfaces.
- E. **Control of Corrosion:** Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS

- A. **Product Data:** For the following:
 - 1. Manufacturer's product lines of railings assembled from standard components.
- B. **Shop Drawings:** Include plans, elevations, sections, details, and attachments to other work.
- C. **Samples for Verification:** For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Each type of glass required.
 - 3. Fittings and brackets.
 - 4. Welded connections.
 - 5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Samples need not be full height.
- D. **Delegated-Design Submittal:** For installed products indicated to comply with performance requirements and design criteria, including analysis data **signed and sealed by the qualified professional engineer licensed in Texas responsible for their preparation with a**

minimum of 10 years' experience designing architectural railing systems of a similar nature.

- E. **Qualification Data:** For qualified professional engineer.

1.6 QUALITY ASSURANCE

- A. **Source Limitations:** Obtain each type of railing from single source from single manufacturer.
- B. **Product Options:** Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including structural analysis, preconstruction testing, field testing, and in-service performance.
1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- C. **Welding Qualifications:** Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.6, "Structural Welding Code - Stainless Steel."
- D. **Safety Glazing Labeling:** Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- E. **Mockups:** Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
1. Build mockups as shown on Drawings. If not indicated on drawings follow requirements below.
2. Build mockups for each form and finish of railing consisting of two posts, top rail, infill area, and anchorage system components that are full height and are **not less than 48 inches in length**.

1.7 PROJECT CONDITIONS

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

1.8 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not suit structural performance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Refer to Section 008900 - Finish Selection Summary.
- B. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. **Decorative Interior Railings:**
- a. Viva Railings, Carrollton, Texas.
- b. ETI.

- c. Blum, Julius & Co., Inc.
 - d. Blumcraft of Pittsburgh.
 - e. Livers Bronze Co.
 - f. Wagner, R & B, Inc.; a division of the Wagner Companies.
2. **Basis of Design:**
- a. **Decorative Exterior Painted Architectural Metal Railings System (Not Used):**
Refer to the Drawings for shapes, finishes, and profiles.
 - 1) **Finish:** 3 coat epoxy; refer to Section 099713 - Steel Coatings.
 - b. **Stainless Steel Cable Railing System:**
 - 1) **Basis of Design:** Refer to Section 008900 - Finish Selections Summary.
- 2.2 **METALS, GENERAL**
- A. **Metal Surfaces, General:** Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
 - B. **Brackets, Flanges, and Anchors:** Same metal and finish as supported rails unless otherwise indicated.
 - 1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
 - 3. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.
 - 4. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.
- 2.3 **STAINLESS STEEL**
- A. **Tubing:** ASTM A 554, Grade MT 316 304.
 - B. **Pipe:** ASTM A 312/A 312M, Grade TP 316 304.
 - C. **Castings:** ASTM A 743/A 743M, Grade CF 8 or CF 20.
 - D. **Sheet, Strip, Plate, and Flat Bar:** ASTM A 666, Type 316 304.
 - E. **Bars and Shapes:** ASTM A 276, Type 316 304.
 - F. **Cable:** ASTM A 492, Type 316, 3/16" in diameter.
- 2.4 **STEEL AND IRON**
- A. **Tubing:** ASTM A 500 (cold formed) or ASTM A 513.
 - B. **Bars:** Hot-rolled, carbon steel complying with ASTM A 29, Grade 1010.
 - C. **Plates, Shapes, and Bars:** ASTM A 36.
- 2.5 **GLASS AND GLAZING MATERIALS (NOT USED)**
- A. **Tempered Glass:** ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
 - 1. **Glass Color:** Clear.
 - 2. **Thickness for Structural Glass Balusters:** As engineered by manufacturer and required for structural loads, but not less than 1/2 inch (12 mm).
 - B. **Glazing Gaskets for Glass Infill Panels:** Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.
- 2.6 **ILLUMINATED RAILINGS (NOT USED)**
- A. **Illuminated Units:** Provide internal illumination using concealed, internally wired LED-strip fixture system to illuminate walking surfaces adjacent to railings without light leaks. Make provisions for servicing and for concealed connection to electric service. Coordinate electrical characteristics with those of the power supply provided.

1. **LED Lighting:** Provide number of fixtures required by railing length.
2. **Diffusers:** UV-stabilized acrylic diffusers matching profile of railings.
3. **Drivers:** Energy-saving, high power factor; designed for use with high-output LED lighting and with automatic-reset thermal protection.

2.7 FASTENERS

- A. **Fastener Materials:** Unless otherwise indicated, provide the following:
 1. **Stainless-Steel Components:** Type 316 stainless-steel fasteners.
 2. **Dissimilar Metals:** Type 316 stainless-steel fasteners.
- B. **Fasteners for Anchoring to Other Construction:** Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated.
- C. **Provide concealed fasteners** for interconnecting railing components and for attaching railings to other work unless noted otherwise.
- D. **Exposed Fasteners:**
 1. At plate connections of balusters to stringers, provide carriage bolt square shoulder round-head screws in same finish as railing for exposed fasteners unless otherwise indicated.
- E. **Anchors, General:** Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- F. **Post-Installed Anchors:** Torque-controlled expansion anchors.
 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.8 MISCELLANEOUS MATERIALS

- A. **Welding Rods and Bare Electrodes:** Select according to AWS specifications for metal alloy welded.
- B. **Non-shrink, Non-metallic Grout:** Factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.9 FABRICATION

- A. **General:** Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Make up **wire-rope assemblies** in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
- D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- E. Form work true to line and level with accurate angles and surfaces.
- F. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- G. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- H. **Connections:** Fabricate railings with welded connections unless otherwise indicated.
- I. **Welded Connections:** Cope components at connections to provide close fit, or use fittings

designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

J. **Mechanical Connections:** Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

K. **Form changes in direction as follows:**

1. By bending.

L. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

M. Close exposed ends of hollow railing members with prefabricated end fittings.

N. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.

O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

Q. For railing posts set in concrete, provide stainless-steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

2.10 **GLAZING PANEL FABRICATION (NOT USED)**

A. **General:** Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.

1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.

B. **Infill Panels:** Provide tempered glass panels for both straight and curved sections.

2.11 **GENERAL FINISH REQUIREMENTS**

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.12 **FINISHES**

A. **Interior Stainless Steel Railings:**

1. Stainless Steel Members: Brushed #4 finish. Refer to Section 008900 - Finish Selection Summary.

B. **Exterior Painted Steel Railings:**

1. **Painted Steel Members:** Epoxy as specified in Section 099713 - Steel Coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. **Corrosion Protection:** Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. **Non-welded Connections:** Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. **Welded Connections:** Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.4 ANCHORING POSTS

- A. **Exterior Locations:** Unless noted otherwise on drawings, install as follows:
 - 1. Use steel pipe sleeves preset and anchored into concrete for installing posts at exterior locations. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, non-metallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
 - 2. Form or core-drill holes not less than 5 inches deep (verify with slab thickness and structural engineer) and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, non-metallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
 - 3. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
 - 4. Leave anchorage joint exposed with anchoring material flush with adjacent surface.
 - 5. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting member.
- B. **Interior Locations:**
 - 1. For stainless-steel railings, weld posts to stainless steel plates and bolt to metal-stair stringer surface with four large carriage (square shoulder) bolts per post.
 - 2. Attach to side of metal stringers.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with brackets on underside of rails connected to

- railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
 - C. Attach handrails to walls with wall brackets except where end flanges are used. **Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface.** Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
- 3.6 **INSTALLING GLASS PANELS (NOT USED)**
- A. **Post-Supported Glass Railings:** Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles. Erect posts and other metal railing components, then set factory-cut glass panels. Do not cut, drill, or alter glass panels in field. Protect edges from damage.
- 3.7 **CLEANING**
- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
 - B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
 - C. Clean by wiping with a damp cloth and then wiping dry.
- 3.8 **PROTECTION**
- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
 - B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05 73 53

SMOKE BAFFLE CURTAIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:** Aluminum channel and glass curtain.

1.3 SUBMITTALS

- A. **Product Data:** Manufacturer's data including description of materials, components, finishes, and installation instructions.
- B. **Shop Drawings:** Include plans, elevations, sections, and attachment details.
- C. **Samples for Verification:** For each type of exposed finish required.
 - 1. Sections of linear channel member.
 - 2. Each type of glass required.

1.4 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Contract Documents are based on products specified in Section 008900 - Finish Selection Summary to establish a standard of quality. Other available manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as judged by Architect.
- B. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. CRL Architectural Products.
 - 2. Livers Bronze Co.

2.2 MATERIALS

- A. **Aluminum Channel:**
 - 1. General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.
 - 2. Extruded Shapes: ASTM B 221, Alloy 6063-T5/T52.
- B. **Tempered Glass:** ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality-Q3. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
 - 1. Color: Clear.
 - 2. Thickness: 19.0 mm.
 - 3. **Height: 18 inches.**
- C. Sealant: Manufacturers standard silicone sealant.

- D. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated.

2.3 ALUMINUM FINISHES

- A. **Baked-Enamel or Powder-Coat Finish:** AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install assembly to comply with manufacturer's written instructions.
- B. Install components plumb, level, square, true to line, and rigid.
- C. Fit aluminum connections together to form tight, hairline joints.
- D. Install glass securely in channel using mechanical fasteners and grommets.
- E. Install sealant at joints between glass panels.
- F. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.

END OF SECTION

SECTION 061013

MISCELLANEOUS ROUGH CARPENTRY

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:**
 - 1. **Oriented-Strand-Board.**
 - 2. **Preservative treatment.**
 - 3. **Fire retardant treatment.**
 - 4. **Fasteners.**
 - 5. **Related accessories.**

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Product Data:** Provide technical data on wood preservative and fire retardant treatment materials and application techniques and instructions.
- C. **Manufacturers Certificates:** Certify that products meet or exceed specified requirements.
 - 1. **Pressure Treated Wood:** **Submit certification** by treating plant stating chemicals and process used, net amount of salts retained, and conformance with referenced standards.
 - 2. **Preservative Treated Wood:** **Submit certification** for water-borne preservative that moisture content was reduced to maximum 19 percent for lumber and 15 percent for plywood after treatment.
 - 3. **Fire Retardant Treated Wood:** **Submit certification** by testing plant stating chemicals and process used, conformance with referenced standards and governing ordinances, and non-bleeding quality of the treatment.
 - 4. **Structural Values:** Where materials are provided to comply with minimum allowable unit stresses, **submit listing of species and grade selected for each use**, in the form of a signed copy of the applicable portion of the producer's grading rules for design values.

1.4 QUALITY ASSURANCE

- A. **Lumber Grading:** Lumber Grading Rules and Wood Species in accordance with Voluntary **Product Standards**. Grading rules of following associations apply to materials furnished.
 - 1. Southern Pine Inspection Bureau (SPIB).
 - 2. West Coast Lumber Inspection Bureau (WCLIBB).
 - 3. Western Wood Products Association (WWPA).
- B. **Grade Marks:** Identify lumber and plywood by official grade mark.
 - 1. Lumber: Include symbol of grading agency, mill name, grade, species, grading rules and condition of seasoning at time of manufacturer.
 - 2. Plywood: Include type, class identification index, and agency mark.
 - 3. Pressure Treatment: Include quality mark of grading agency which maintains continued supervision, testing, inspection, and re-examination service over product quality as described in AWWPA standards.
 - 4. Fire Retardant Treated Wood: Mark attesting FR-S rating.
- C. **Requirements of Regulatory Agencies**
 - 1. Preservative and Pressure Treated Lumber and Plywood: Comply with American Wood Preservers Bureau Standards.

2. Fire Retardant Treated Materials: Comply with Underwriters Laboratories, Inc. and ASTM E 84, for maximum flame spread of 25.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, handle, and protect products in accordance with Section 016000.
- B. Store products above ground, on platforms or skids, and covered with waterproof coverings. Provide for adequate air circulation.
- C. Do not store seasoned materials in damp or wet locations.
- D. Support products in such a way as to prevent warping and distortion.

PART 2 - PRODUCTS

2.1 WOOD MATERIALS

- A. General: Where stress rating values are given in lieu of grades, select any quality which will meet structural requirements.
- B. **Lumber**
 1. **Grading Rules:** PS 20.
 2. Lumber shall be kiln dried, bearing stamp of Southern Pine Inspection Bureau or equivalent agency.
 3. **Dimensions:** Lumber dimensions are nominal except for posts and timbers; actual dimensions conform to industry standards established by the American Lumber Standards Committee and applicable rules writing agencies. Provide sizes as detailed.
 4. **Moisture Content:** 19 percent maximum moisture content after treatment for fire retardant and preservative treated woods.
 5. **Surfacing:** Surface four sides (S4S), unless noted otherwise.
 6. **Species: Southern Yellow Pine or West Coast Douglas Fir, unless noted otherwise.**
 7. **Finger-Jointed Lumber: Not allowed.**
 8. **Uses, Grades, and Stress Ratings**
 - a. **Non-structural light framing** (2 to 4 inch thick, 2 to 4 inch wide):
 - 1) **General Framing:** Standard and better or Stud grade.
 - 2) **Plates, Blocking, Bracing, Nailers:** Utility grade.

2.2 ORIENTED-STRAND BOARD

- A. **Oriented-Strand-Board:** Exposure 1 sheathing.
 1. **Span Rating:** Not less than 24/0.
 2. **Nominal Thickness:** Not less than 1/2 inch (13 mm).

2.3 ACCESSORIES

- A. **Plastic Cement:** ASTM D 2822, asphalt base.
- B. **Fasteners**
 1. Provide fasteners in sizes, spacings, and locations to suit applications. Hot dip galvanize unless noted otherwise.
 2. **Anchors:**
 - a. Toggle Bolt Type: For anchorage to hollow masonry.
 - b. Expansion Shield and Lag Bolt Type: For anchorage to solid masonry or concrete.
 - c. Bolts or Ballistic Fasteners: For anchorage to steel.
 3. **Bolts:** ASTM A 307 with nuts and washers.
 4. **Anchor Bolts:** ASTM A 307 with nuts and washers.
 5. **Toggle Bolts:** ASTM A 307.
 6. **Lag Screws and Lag Bolts:** ANSI B18.2.1 with washers.
 7. **Wood screws:** ANSI B18.6.1.

8. **Nails, Staples, and Spikes:** FS FF-N-105.
9. **Metal Nailing Discs**
 - a. Flat caps, minimum 1 inch diameter.
 - b. Minimum 30 gage sheet metal.
 - c. Formed to prevent dishing.
 - d. Bell or cup shapes not acceptable.

2.4 WOOD TREATMENTS - SHOP PREPARED

A. **Preservative Treated Wood**

1. **Provide preservative treat fascia blocking at all roof edging, sill plates and grounds in contact with concrete (except on interior of building) roof curbs, cants and nailers for flashing, and elsewhere as noted or shown.**
 - a. Contractor shall provide certification for preservative treated material.
2. Use waterborne salt preservatives as follows:
 - a. AWPB LP-2 above ground.
 - b. AWPB LP 22 ground contact.
3. Redry lumber to maximum 19 percent moisture content, stamp with AWPB "Dry". Redry plywood and particleboard to 15 percent maximum moisture content.
4. **Field treat surface cuts and holes in accordance with AWPB M4.**
 - a. Water repellent containing 2 percent copper naphthenate solution.
 - b. Compatible with preservative pressure treatment.
 - c. Pigment: Colored.
 - d. **Acceptable Products:**
 - 1) Number 10 Green Preservative by Cuprinol Group (Sherwin Williams), Cleveland, OH.
 - 2) Substitutions: Submit in accordance with Section 016000.

B. **Fire Retardant Treated Wood**

1. **Use fire retardant treated wood for wood blocking above ceilings, blocking within return air plenums, blocking within walls, and other areas required by reference building codes.**
 - a. Contractor shall provide UL label for fire retardant material.
2. Comply with AWPB C20 for lumber and AWPB C27 for sheet materials.
3. Not detrimental to structural properties of plywood when exposed to elevated temperatures and high humidity when tested in accordance with ASTM D 5516.
4. **Not capable of bleeding through or adversely affecting type of finish indicated.**
5. Not capable of corroding metals when tested in accordance with MIL-L-199140E.
6. Provide finished products with maximum flame spread rating of 25 when tested in accordance with ASTM E 84.
7. **Acceptable Products and Manufacturers - Interior**
 - a. D-Blaze by Chemical Specialties, Inc., Charlotte, NC.
 - b. Dricon by Hickson Corporation, Atlanta, GA.
 - c. Pyroguard by Hoover Treated Wood Products, Thomson, GA.
 - d. Substitutions: Submit in accordance with Section 016000.
8. **Acceptable Products and Manufacturers - Exterior**
 - a. Exterior Fire-X by Hoover Treated Wood Products, Thomson, GA.
 - b. Substitutions: Submit in accordance with Section 016000.
9. Where treated items are exposed to exterior or to high humidity or are to have a transparent finish applied, provide materials which show no change in fire hazard classification when subjected to standard rain test (UL 790).
10. Use fire retardant treatment which will not bleed through or adversely affect type of finish indicated and which does not require brush treatment of field- made end cuts to maintain fire hazard classification.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready to receive work of this section. Notify Owner's Representative of any existing conditions which will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 PREPARATION

- A. **Wood Treatment Applied to Cut Surfaces at Site:** Comply with AWP4 M4.
 - 1. Apply preservative treatment in accordance with manufacturer's instructions to:
 - a. Preservative pressure treated wood site-sawn ends.
 - b. Holes cut through preservative pressure treated wood.
 - 2. Allow preservative to cure prior to erecting members.

3.3 INSTALLATION

- A. **General**
 - 1. Discard units of material with defects which might impair quality of work, and units which are too small to fabricate work with minimum joints or optimum joint arrangement.
 - 2. Set carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted. Scribe and cope as required.
 - 3. Securely attach carpentry work to substrates by anchoring and fastening as required by recognized standards and as required to draw members into place and securely hold same unless otherwise indicated. Use washers under bolt heads.
 - 4. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials.
 - 5. Make tight connections between members to develop full strength of members.
 - 6. Install fasteners without splitting of wood.
 - 7. Predrill as necessary.
 - 8. Comply with APA E30a requirements for plywood.
 - 9. Install fasteners at spacing recommended by NFPA National Design Specifications for Stress Grade Lumber and Its Fastening - 1973 for lumber and APA Guide E30e for Plywood, unless more restrictive code requirements dictate tighter spacing or heavier fasteners.
 - 10. Locate members as indicated on the drawings. Do not change size, spacing or spans without specific approval of Owner's Representative. Take care to place proper grades and species of members where indicated in accordance with the lumber schedule herein.
 - 11. Temporarily brace framing at the end of each day's work until framing is completed and securely anchored. Leave temporary bracing in place as long as required for safety. As work progresses, securely connect work to compensate for dead load, wind, and erection stresses.
 - 12. Shimming:
 - a. Concrete and masonry bearing: Use steel or slate shims.
 - b. Metal and Wood Bearing: Do not use shims.
 - 13. **Wood Fire Retardant Pressure Treatment:**
 - a. Do not rip cut.
 - b. Do not mill.
 - c. **Only end cuts and bored holes are permitted.**
- B. **Wood Grounds, Nailers, Cants, and Blocking**
 - 1. Provide where required for screeding or attachment of other work.
 - 2. Form to shapes cut as necessary for true line and level of work to be attached.
 - 3. Coordinate location with other work involved.
 - 4. Attach to substrates to support applied loading.
 - 5. Countersink bolts and nuts flush with surfaces and where built into masonry work.

6. Where possible, anchor to formwork before concrete placement.
 7. Provide permanent grounds of dressed, preservative treated, key beveled lumber not less than 1/2 inch wide, and of thickness required to bring face of ground to exact thickness of finish material involved.
 8. Provide continuous blocking.
 9. Remove temporary grounds when no longer required.
 10. Curb roof openings except where prefabricated curbs are provided.
 11. Provide solid lumber preservative cants where roof surfaces meet walls, curbs or other vertical projections.
 12. Install wood blocking behind/above:
 - a. Toilet partitions.
 - b. Toilet accessories.
 - c. Grab bars.
 - d. Mirrors.
 - e. All wall mounted equipment.
 - f. Upper and lower cabinets and shelving.
 - g. Movable partitions.
 - h. Other locations as required and/or called for in individual specification sections.
- C. **Plywood Equipment and Panel Boards:** Install full height painted plywood behind all electrical panels and other equipment whether or not called for on plans.
1. Oversize panel by 12 inches beyond equipment perimeter.
- D. **Wood Nailers:** Provide at roof openings, terminations, and other locations as indicated to match thickness of roof insulation.
- E. **Wood Cants:** Provide where roofing meet walls, curbs, and other vertical projections.
- F. **Wood Curbs:** Provide at roof openings except where prefabricated curbs are provided. Form corners by lapping side members alternately.
- G. **Wood Furring:**
1. Run in longest practical lengths.
 2. Butt ends together.
 3. Rigidly secure to substrate.
- 3.4 TOLERANCES
- A. **Framing members:** 1/4 inch maximum from true position.
 - B. **Surface flatness of floors/roofs:** 1/4 inch in 10 feet maximum.
- 3.5 PROTECTION
- A. Protect products from moisture absorption and subsequent warping or deterioration until subsequent construction can proceed.

END OF SECTION

SECTION 061600

SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. **Wall sheathing.**
2. **Roof sheathing:** Composite nail based insulated roof sheathing for use under asphalt shingle roofs.
3. **Primed sheathing board for back of parapet walls.**
4. **Exterior grade plywood sheathing.**
5. **Sheathing joint and penetration treatment.**
6. **Wood Structural Insulating Panels (SIPS).**

1.3 ACTION SUBMITTALS

- A. **Product Data:** For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.4 QUALITY ASSURANCE

- A. **Testing Agency Qualifications:** For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. **Fire-Test-Response Characteristics:** For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

2.2 WOOD PANEL PRODUCTS

- A. **Oriented Strand Board:** DOC PS 2.
- B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

2.3 WALL SHEATHING

- A. **Glass-Mat Gypsum Wall Sheathing:** ASTM C 1177, moisture resistant type; 1/2 and 5/8 inch thick, maximum permissible length; ends square cut, book or tongue and grooved edges.

1. ~~**Acceptable Products:** Subject to compliance with requirements, provide one of the following:~~
 - a. ~~CertainTeed Corporation; GlasRoc.~~
 - b. ~~G-P Gypsum Corporation; Dens-Glass Sheathing.~~
 - c. ~~Temple Inland Inc.; GreenGlass~~
 - d. ~~United States Gypsum Co.; Securock.~~
 2. ~~**Type and Thickness:** Type X, 1/2 and 5/8 inch thick.~~
 3. ~~**Substitutions:** Refer to Section 012500.~~
 - B. **Wall Sheathing Board:** *Coated fiberglass mat gypsum sheathing with integral weather-resistant barrier (WRB) and air barrier (AB) complying with applicable requirements of ICC-ES AS212, ASTM E 2178, and ASTM E 2357; 5/8 inch thick; Type X.*
 1. **Basis of Design:** *DensElement Sheathing by Georgia Pacific.*
 2. **Substitutions:** *Refer to Section 012500.*
 - C. **Primed Sheathing Board for Back of Parapet Walls:** ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 1/2 inch thick, factory primed.
 1. **Basis of Design:** Dens Deck Prime by Georgia Pacific.
 2. **Substitutions:** Refer to Section 012500.
- 2.4 **ROOF SHEATHING**
- A. Plywood Sheathing: **DOC PS 1, Exterior, Structural I** sheathing; **fire treated**.
 1. Nominal Thickness: Not less than **3/4 inch**.
 2. **Location:** Provide as substrate under all clay roof tiles.
 3. Provide IT clips as required by manufacturer.
- 2.5 **EXTERIOR GRADE PLYWOOD SHEATHING (NOT USED)**
- A. Plywood Sheathing: **DOC PS 1, Exterior, Exposure 1**, CDX plywood.
- 2.6 **STRUCTURAL INSULATING PANELS**
- A. UL certified EPS core with Perform Guard treatment, minimum of 0.95 pcf complying with ASTM C578 Type I and having ICC ES recognition of termite resistance. Insulation manufacturer shall provide Third Party UL certificate. ICC ES report shall be provided for recognition of termite resistance in compliance with ICC AC239.
 - B. OSB identified with APA or TECO performance mark with Exposure I durability rating and performance in accordance with DOC PS-2 span rating 24/16 or greater.
 - C. Adhesives shall be in conformance with ICC ES AC05 – Acceptance Criteria for Sandwich Panel Adhesives.
 - D. Treatment for mold, mildew, and termite resistance meeting the following requirements:
 1. Registered with EPA.
 2. Mold growth: 0 rating, tested to ASTM D3273 for 8 weeks at 77 degrees F and 100 percent relative humidity.
 3. Termite resistance: Minimum rating of 7.0, tested to AWPA E-1.
 4. Corrosion potential for metals in contact with treated wood: Maximum 2 mils per year, tested to AWPA E12 for minimum of 60 days on aluminum 2024, carbon steel, hot-dip galvanized steel, and G90 galvanized steel.
 5. Equivalent lateral resistance and tooth holding capacity as untreated wood.
- 2.7 **JOINT TREATMENT FOR WALL SHEATHING BOARD**
- A. **Primer:** *Liquid primer recommended by air barrier manufacturer for exposed gypsum core edges.*
 1. **Basis of Design:** *PorousPrep Sealer by PROSOCO, Inc.*
 - B. **Fluid-Applied Air Barrier Flashing:** *Site-applied for application to joints, fasteners, penetrations, openings and material transitions.*
 1. **Basis of Design:** *FastFlash by PROSOCO, Inc.*
 - C. **Flashing and Transition Strip:** *Preformed silicone extrusion, 24 mils thick.*
 1. **Basis of Design:** *SureSpan EX by PROSOCO, Inc.*

2.8 FASTENERS

- A. **General:** Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. **For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153.**
- B. **Power-Driven Fasteners:** NES NER-272.
- C. **Wood Screws:** ASME B18.6.1.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. **Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.**
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
- D. **Coordinate wall sheathing installation with flashing and joint-sealant installation** so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. **Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.**
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. **Fastening Methods:** Fasten panels as indicated below:
 - 1. Wall and Roof Sheathing:
 - a. **Screw to cold-formed metal framing.**
 - b. Space panels 1/8 inch apart at edges and ends.
 - 2. Install over continuous waterproof membrane such as Ice and Water Shield by W.R. Grace, or approved equal.

3.3 ~~GYPSUM SHEATHING INSTALLATION~~

- A. ~~Comply with GA-253 and with manufacturer's written instructions.~~
 - 1. ~~Fasten gypsum sheathing to cold-formed metal framing or studs with screws.~~
 - 2. ~~Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.~~
 - 3. ~~Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.~~
- B. ~~Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.~~
- C. ~~Vertical Installation:~~ Install board vertical edges centered over studs. Abut ends and edges of each board with those of adjacent boards. Attach boards at perimeter and within field of board to each stud.
 - 1. ~~Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of boards.~~
 - 2. ~~For sheathing under stucco cladding, boards may be initially tacked in place with screws if overlying self-furring metal lath is screw attached through sheathing to studs immediately after sheathing is installed.~~

3.4 **WALL SHEATHING BOARD INSTALLATION**

- A. Discard each air- and water-resistive sheathing board with damage that compromises continuity or impairs performance as an air barrier, and is unable to be repaired according to manufacturer's written repair instructions.
 - 1. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. **Comply with ASTM C 1280, GA-253, and manufacturer's written instructions.**
 - 1. Fasten sheathing boards to cold-formed metal framing with specified screws in pattern indicated.
 - 2. Install sheathing boards with a 1/4 inch gap where they abut masonry or similar materials that might retain and transmit moisture to them.
- C. Cut sheathing boards at penetrations, edges, and other obstructions of work to allow for application of air barrier accessory materials. Fit sheathing boards closely against abutting construction.
- D. Install sheathing boards with long dimension perpendicular or parallel to framing. Abut ends and edges of sheathing boards centered over face of framing members. Offset sheathing boards joints by not less than one stud spacing.
 - 1. Apply sheathing boards in pieces sized to provide minimum number of joints and optimum sheathing board arrangement. Arrange joints so that pieces do not span between fewer than three support members.
 - 2. Do not bridge building expansion joints; cut and space edges of sheathing boards to match spacing of structural support elements.
- E. Space fasteners maximum 8 inches o.c. and set back a minimum of 3/8 inch (905 mm) from edges and ends of sheathing boards and as required in indicated fire-resistance-rated designs.
 - 1. Apply fasteners so heads are seated flush to board product air barrier membrane surface without breaking or punching through the surface.
 - a. Treat all countersunk fasteners that penetrate through fiberglass with specified fluid-applied flashing used for sealing joints.
 - 2. Securely attach sheathing boards to substrate by fastening as indicated, complying with the following:
 - a. Table 2304.9.1, "Fastening Schedule," in the IBC.
 - b. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 - c. ICC-ES evaluation report for fastener.
 - 3. Use common galvanized wire nails. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
 - 4. Use corrosion resistant sheet metal screw fasteners. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections.
- F. Coordinate wall sheathing boards installation with flashing and air barrier accessory material installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

3.5 **JOINT TREATMENT AT WALL SHEATHING BOARD INSTALLATION**

- A. General: Apply site fluid-applied air barrier flashing at joints, fasteners, penetrations, openings, and material transitions to achieve a continuous air barrier according to air barrier manufacturer's written instructions. Apply within manufacturer's recommended application temperature ranges.
- B. Apply extrusion flashing material in full contact with substrate to produce a continuous seal according to air barrier manufacturers written instructions.
 - 1. Apply extrusion flashing at changes in plane, and inside and outside corners.
- C. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

END OF SECTION

SECTION 062023

INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. Interior Finish Carpentry Work
 1. **Stain grade standing and running trim, including wood base, chair rail, crown molding, composite molding assemblies, and other molding trim shapes.**
 2. **Shelving.**
 3. **Acoustical perforated and non-perforated wall paneling.**
 4. **Wood and glass display cases.**
 5. **Paint grade standing and running trim, including composite molding assemblies, wood base, chair rail, and crown molding.**
 6. **Wood window sills.**

1.3 SUBMITTALS

- A. **Product Data:** Manufacturer's technical literature for factory fabricated items and components.
- B. **Samples:** Submit stained or finished samples of each piece of trim, countertop, and paneling. Provided in sizes requested by Architect.
- C. **Shop Drawings:**
 1. Include plans, elevations, sections, and attachment details.
 2. Show large-scale details and shapes.
 3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
 4. Apply **AWI Quality Certification** Program label to Shop Drawings.
- D. Quality Standard Compliance Certificates: **AWI Quality Certification Program.**

1.4 QUALITY ASSURANCE

- A. **Fabricator Qualifications:** Company specializing in fabrication of custom casework of quality and having **minimum of 10 years documented experience.**
 1. **Shop Certification: AWI's Quality Certification Program accredited participant.**
- B. Fabrication Standards: Fabricate items in accordance with AWI standards listed below **using premium grade.**
 1. **Lumber grades: AWI Section 100.**
 2. **Standing and running trim: AWI Section 300.**
 3. **Counter tops: AWI Section 400.**
 4. **Shelving: AWI Section 600.**
 5. **Miscellaneous work: AWI Section 700.**
 6. **Door frames: AWI Section 900.**
- C. Regulatory Requirements: Conform to applicable code for fire retardant requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, handle, and protect products in accordance with Section 016000.
- B. Protect materials from damage, soiling and deterioration.
- C. Do not deliver finish carpentry materials until job site conditions and operations which could damage, soil or deteriorate work are complete.
- D. Store products and materials in ventilated, interior locations

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Install finish carpentry products only when temperature and humidity conditions have been stabilized and will be maintained.
- B. Maintain temperature and moisture conditions as recommended by woodwork fabricator from date of installation through remainder of construction period.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. Comply with quality and grading standards contained herein for each material.
 - 2. Sizes noted on drawings or indicated herein for lumber are nominal unless detailed by specific dimensions of actual size.
 - 3. Plywood and particleboard thicknesses are noted or detailed.
 - 4. Products surfaced four sides, unless noted otherwise.
- B. **Softwood Lumber:**
 - 1. Quality standard: PS 20.
 - 2. **Grading Standard: AWI Custom Grade.**
 - 3. **Maximum moisture content: 6% for interior work; 10% for exterior work.**
 - 4. Species: Idaho white pine, or poplar.
 - 5. Grain: Mixed.
- C. **Hardwood Lumber:**
 - 1. Quality standard: FS MM-L-736C.
 - 2. **Grading standard: AWI Premium Grade**
 - 3. **Maximum moisture content: 6 percent.**
 - 4. **Species: Match Architect's control sample.** Refer to Section 008900 - Finish Selection Summary.
 - 5. **Grain: Match Architect's control sample.** Refer to Section 008900 - Finish Selection Summary.
- D. **Softwood Plywood:**
 - 1. Quality standard: PS 1.
 - 2. **Grading standard: AWI Custom Grade**
 - 3. Core material: C-D Plugged INT-APA.
 - 4. Face quality: A-B INT-APA and Medium density overlay.
 - 5. **Species: Douglas fir.**
 - 6. Ply construction: 3 ply - 3/8 inch; 5 ply-1/2 inch; 7 ply - 3/4 inch.
- E. **Hardwood Plywood:**
 - 1. Quality standard: FS MM-L-736C.
 - 2. **Grading standard: AWI Premium Grade**
 - 3. **Maximum moisture content: 6 percent.**
 - 4. **Species: Match Architect's control sample.** Refer to Section 008900 - Finish Selection Summary.
 - 5. **Grain: Match Architect's control sample.** Refer to Section 008900 - Finish Selection Summary.
- F. **Laminate Materials:**
 - 1. **High pressure laminate surface:**
 - a. Quality standard: NEMA, LD-3.
 - b. **Grade:** AWI Custom Grade.
 - c. Thickness: 0.050 inch for horizontal grade; 0.028 to 0.032 inch for vertical grade.
 - d. Core: Standard.
 - e. **Finish and Sheen:** To be selected by Architect from any and all of the manufacturer's product lines listed in this section for colors selected. Sheen to be selected by Architect from specified product manufacturing full line of sheens available.
 - f. **Acceptable Manufacturers:**

- 1) Wilsonart by Ralph Wilson Plastics, Temple, TX.
 - 2) Nevamar by Exxon Chemical Co., Odenton, MD.
 - 3) Formica by Formica Corp., Wayne, NJ.
 - 4) Lamin-Art, Inc.
 - 5) Pionite.
 - 6) Arborite.
 - 7) Substitutions: Submit in accordance with Section 016000.
2. **Laminate Backing Sheets**
 - a. Composition: High pressure laminate of paper and melamine, without decorative finish, 0.020 inch thick minimum.
 - b. Acceptable manufacturers: Same as for high pressure laminate surfacing.
- G. Medium Density Fiberboard (MDF):**
1. **Product made without formaldehyde** and complying with ANSI A208.2, Product Class MD.
 2. **Acceptable Product:** Medite II as manufactured by Medite Corporation.
- H. Acoustical Perforated and Non-Perforated Wall Paneling Basis of Design:**
1. **Manufacturer, Product, Wood Species, and Finish:** Refer to Document 008900 - Finish Selections Summary.
- 2.2 ACCESSORIES AND TREATMENT
- A. **Contact Adhesive:** FS MMM-A-130B, of type recommended by millwork manufacturer to suit application.
 1. **Adhesive not to be water-based.**
 - B. Bolts, Nuts, Washers, Lags, Pins, Nails, and Screws: Size and type to suit application.
 - C. Nails: Size and type to suit application, plain finish.
- 2.3 SHOP FABRICATION
- A. Shop fabricate laminate assemblies in accordance with approved shop drawings; **AWI Custom Grade standards and mill wood with Premium Grade standards.**
 - B. Sanding/Filling
 1. Perform work in accordance with AWI.
 2. Sand work smooth and set exposed nails and screws.
 - C. Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and other fixtures. Verify locations of cutouts from site dimensions. **Seal edge surfaces of cutouts.**
 - D. Before proceeding with millwork required to be fitted to other construction, obtain measurements and verify dimensions of shop drawings details for accurate fit.
 - E. Fabricate woodwork to dimensions, profiles, and details shown.
 - F. Route and groove back of flat trim members, kerf backs of other wide flat members except plywood or veneered members.
 - G. Assemble in mill in as large of units as practicable to minimize field cutting and fitting.
 - H. Miter joints, where required, by joining, splining, and gluing to comply with requirements for specified grade.
 - I. Cap exposed plywood edges with hardwood trim, 3/8 inch x width of sheet.
 - J. On countertops, perform the following
 1. **Apply laminate finish in full, uninterrupted sheets of maximum practical lengths.**
 2. **Form corners and butt joints with hairline joints.**
 3. **Do not locate joints within 2 feet of sink cut-out.**
 4. **Cap exposed edges with laminate.**
 - K. Mill wood moldings to stock shapes, patterns, and sizes with profiles as indicated on drawings.
- 2.4 **SHOP FINISHING**
- A. General: Finish architectural cabinets at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
 - B. **Transparent Finish:**
 1. **Grade:** Premium.

2. **Finish:** System - 2, precatalyzed lacquer.
3. Wash coat helps prevent blotchiness with wiping stains.
4. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
5. **Staining:** Match Architect's sample.
6. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
7. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
8. **Sheen:** Semigloss, 46-60 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces, openings and conditions are ready to receive work of this section. Notify General Contractor of any existing condition which will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.
- B. Verify that field measurements are as shown on shop drawings.
- C. Verify that mechanical, electrical, and other items affecting work of this section are in place and ready to receive the work.
- D. Beginning of installation indicates acceptance of existing conditions.

3.2 PREPARATION

- A. Prime paint or seal concealed surfaces and items or assemblies which will be in contact with cementitious materials or surfaces.
- B. Make field cuts with extreme care to avoid splintering.

3.3 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturer's printed instructions and recommendations.
- B. **Install laminate work in accordance with AWI Custom Quality Standards and mill work in accordance with AWI Premium Grade Quality Standards.** Handle materials to avoid dents and other damages.
- C. Set and secure materials and components, rigid, plumb, and square.
- D. Shim as required using concealed shims.
- E. Cut to fit to exact size. Where woodwork abuts other finished work, scribe and cut for accurate fit. Where necessary to fit at site, provide ample allowance for cutting and fitting.
- F. Before making cutouts, drill pilot holes at corners.
- G. Distribute defects allowed in quality grade to best overall advantage when installing job assembled woodwork items.
- H. Install trim and molding in unjointed lengths for openings and for runs less than maximum length of lumber available. For longer runs, use only one piece less than maximum length available in straight run.
- I. Stagger joints in adjacent members.
- J. Cope moldings at returns and miter at corners.
- K. Attach woodwork securely in place with uniform joints providing for thermal and building movements; **blind nail where possible.**
- L. Use finishing nails where exposed.
- M. Set exposed heads for filling, except for exterior wood to receive natural finish.
- N. Secure woodwork to anchors, with built-in blocking.
- O. Preparing for Finish
 1. **Clean woodwork and fill nail holes. Sand to smooth finish.**
 2. **Where woodwork is to receive transparent finish, use matching wood filler.**
- P. Install hardware in accordance with manufacturer's recommendations.

- Q. **Cover exposed edges of sheet goods used for shelving and other items with 3/8 inch thick hardwood edging.** Width of edging to match thickness of shelving.
 - R. **Finish wood paneling shall be installed in continuous series as it comes off the veneer roll. Panels are to be sequentially numbered during fabrication.**
 - S. On field applied laminate plastic work:
 - 1. Apply plastic laminate finishes where indicated.
 - 2. Adhere with adhesive over entire surface. Make joints and corners hairline.
 - 3. Match patterns. Slightly bevel arises.
 - 4. **Cap exposed edges with plastic laminate of same finish and pattern.**
 - 5. **Apply laminate backing sheet on reverse side of plastic laminate finished surfaces.**
 - T. Secure casework to anchors, built-in blocking, or directly attach to substrates where capable of adequately supporting load. Use toggle bolt type fasteners for wall mounted components. Secure countertops to base cabinets.
 - U. Install hardware in accordance with manufacturer's recommendations.
- 3.4 TOLERANCES FOR FIELD ASSEMBLIES/JOINED ITEMS
- A. Maximum Variation from True Position: 1/16 inch.
 - B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.
- 3.5 ADJUSTING
- A. Adjust work under provisions of Section 017700.
 - B. Adjust moving or operating parts to function smoothly and correctly.
- 3.6 CLEANING AND PROTECTION
- A. Protect installed millwork from marring defacement or other damage until final completion.
 - B. Clean spaces of debris, vacuum and dust all millwork. Leave in condition ready for use.
- 3.7 **SCHEDULE**
- A. Interior
 - 1. Refer to 008900 for finishes and wood species.
 - 2. **Window Sills, Aprons, Moldings, Casings, Chair Rails, Miscellaneous Trim** and elsewhere where other materials are not indicated: **Stain grade select wood** to match Architect's sample, **AWI Premium Grade**.
 - a. Provide 3/4 inch thick paint grade wood sills with bullnose front edges and 4 inch wood molding at typical window openings **at all windows unless noted otherwise on drawings.**
 - 3. **Chair Rails:**
 - a. 4" stain grade CH038 by TWC.
 - 4. **Crown Molding (Not Used):**
 - a. Refer to drawings for size and profiles.
 - 5. **Wood Base:**
 - a. 6" stain grade wood base. Refer to drawings for size and profiles.

END OF SECTION

SECTION 064100

CUSTOM CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section includes:**
 - 1. **Stain grade wood cabinetry.**
 - 2. **Plastic laminate base and wall cabinets.**

1.3 DEFINITIONS

- A. **Exposed:** Where used herein, "exposed" portions of casework includes surfaces visible when doors and drawers are closed. Bottoms of cases more than 4'-0" above finish floor are considered exposed. Visible surfaces in open cases or behind clear doors also are considered as exposed portions.
- B. **Semi-Exposed:** Where used herein, "semi-exposed" portions of cabinet work includes those members behind opaque doors, such as shelves, divisions, interior faces of ends, case backs, drawer sides, backs and bottoms, and back face of doors. Tops of cases 6 feet - 6 inch or more above finish floor shall be considered semi-exposed.

1.4 SUBMITTALS

- A. General: Submit following items in accordance with Section 013300.
- B. **Product Data:** Manufacturer's specifications and installation instructions for hardware and accessory items and for fire retardant treatment.
- C. **Shop Drawings**
 - 1. Indicate profiles, sections, and views of stock items as well as specially fabricated items for the work, at scale large enough to permit checking for design conformity.
 - 2. Indicate sizes, quantities, markings, materials, wood species, finishes and accessories.
 - 3. Include assembly and installation drawings to show methods of blocking, fastening, bracing, jointing, and connecting to work of other trades.
 - 4. Indicate dimensions necessary for fitting casework and adjacent equipment and appliances to fixed planes. Be responsible for details and dimensions not controlled by job conditions.
 - 5. Indicate cut-out locations.
 - 6. Apply **AWI Quality Certification** Program label to Shop Drawings.
- D. **Samples**
 - 1. **Two sample panels, 8" x 10" of each type of high pressure laminates.**
 - 2. **Two 8" x 10" samples of each type and species of plywood and finish lumber with applied finish.**
 - 3. **One of each type of hardware specified.**
- E. Quality Standard Compliance Certificates: **AWI Quality Certification Program.**
- F. **Qualification Data:** Submit **erector qualifications** verifying **ten (10) years minimum of experience**; include list of completed projects having similar scope of work identified by name, location, date, reference name and phone number.

1.5 QUALITY ASSURANCE

- A. **Fabricator Qualifications:** Company specializing in fabrication of custom casework of quality and having **minimum of 10 years documented experience.**
 - 1. Shop Certification: **AWI's Quality Certification Program accredited participant.**

- B. Fabrication Standards: **Fabricate all products and items in accordance with AWI standards listed below using Premium Grade for stain grade millwork and Custom Grade for plastic laminate millwork unless noted otherwise.**
 - 1. Lumber grades: AWI Section 100.
 - 2. Standing and running trim: AWI Section 300.
 - 3. Cabinets and Counter tops: AWI Section 400.
 - 4. Miscellaneous work: AWI Section 700.
- 1.6 DELIVERY, STORAGE AND HANDLING
 - A. Deliver, store, handle, and protect products in accordance with Sections 016000.
 - B. Protect materials from damage, soiling and deterioration.
 - C. Do not deliver finish carpentry materials until job site conditions and operations which could damage, soil or deteriorate work are complete.
 - D. Store products and materials in ventilated, interior locations under constant minimum temperature of 60 degrees F. and relative humidity not to exceed 55 percent.
- 1.7 ENVIRONMENTAL REQUIREMENTS
 - A. Maintain temperature and moisture conditions as recommended by casework fabricator from date of installation through remainder of construction period.
- 1.8 FIELD MEASUREMENTS
 - A. Verify that field measurements are as indicated on shop drawings.
- 1.9 SEQUENCING AND SCHEDULING
 - A. Verify that blocking is in place and backpriming complete before beginning work.

PART 2 - PRODUCTS

- 2.1 CUSTOM CASEWORK, GENERAL
 - A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. Provide inspections of fabrication and installation together with labels and certificates from **AWI certification program** indicating that woodwork complies with requirements of grades specified.
 - 2. The Contract Documents contain requirements that are more stringent than the referenced woodwork quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- 2.2 MATERIALS
 - A. General:
 - 1. Comply with quality and grading standards contained herein for each material.
 - 2. Sizes noted on drawings or indicated herein for lumber are nominal unless detailed by specific dimensions of actual size. Minimum thickness is nominal 1 by material - unless noted or shown otherwise.
 - 3. Plywood: 3/4 inch thickness unless noted or detailed otherwise.
 - 4. Products surfaced four sides, unless noted otherwise.
 - 5. **All of the following products may not be used on this project.**
 - B. **Softwood Lumber:**
 - 1. Quality standard: PS 20.
 - 2. Grading Standard: **AWI Custom Grade**.
 - 3. Maximum moisture content: 6 percent for interior work; 10 percent for exterior work.
 - 4. **Species: Idaho white pine or poplar.**
 - 5. Grain: Mixed.
 - C. **Softwood Plywood:**

1. Quality standard: PS 1.
 2. Grading standard: **AWI Custom Grade.**
 3. Core material: C-D Plugged INT-APA. Provide marine grade plywood at all kitchen cabinet components.
 4. Face quality: A-B INT-APA and Medium density overlay (at counter tops, provide marine grade plywood).
 5. **Species: Douglas fir.**
 6. Ply construction: 3 ply - 3/8 inch; 5 ply-1/2 inch; 7 ply - 3/4 inch.
- D. **Hardwood Lumber:**
1. Quality standard: FS MM-L-736C.
 2. Grading standard: **AWI Premium Grade.**
 3. Maximum moisture content: 6%.
 4. **Species and Grain: Select quality, wood to match Architect's sample.** Refer to Section 008900 - Finish Selections Summary.
- E. **Hardwood Plywood:**
1. Quality standard: PS51.
 2. Grading standard: **AWI Premium Grade.**
 3. Core material: Fir Veneer.
 4. **Species and Grain: Select quality, wood to match Architect's sample.** Refer to Section 008900 - Finish Selections Summary.
 5. Ply construction: 3 ply - 3/8 inch; 5 ply - 1/2 inch; 7 ply - 3/4 inch.
- F. **Hardboard:**
1. Quality standard: PS 58.
 2. Grade: Tempered.
 3. Face: One face sanded.
 4. Thickness: 1/4 inch.
- G. **Laminate Materials:**
1. High Pressure Laminate Surface
 - a. Quality standard: NEMA, LD-3.
 - b. Grade: General Purpose.
 - c. Thickness: 0.050 inch for horizontal grade; 0.028 to 0.032 inch for vertical grade.
 - d. Core: Standard.
 - e. **Finish and Colors:** Architect Reserves the right to select from any of the following manufacturer's full and complete lines of plastic laminates.
 - f. **Acceptable Manufacturers:**
 - 1) Wilsonart.
 - 2) Nevamar.
 - 3) Lamin-Art.
 - 4) Formica.
 - 5) Pionite.
 - 6) Substitutions: In accordance with Section 016000.
 2. Laminate Backing Sheets
 - a. Composition: High pressure laminate of paper and melamine, without decorative finish, 0.020 inch thick minimum.
 - b. Acceptable Manufacturers: Same as for high pressure laminate surfacing.
- H. **Bullet Resistant Panels: (NOT USED)**
1. Description: Panels made by saturating a synthetic fiber mesh made from Kevlar-like material with resin; flat layers of resin soaked mesh are squeezed and baked by an industrial press.
 2. Ballistic Level: 3.
 3. **Location:** Provide at vertical surfaces and secure as required at Council Dais in Council Chambers.

2.3 ACCESSORIES AND TREATMENT

- A. Contact Adhesive: FS MMM-A-I30B of type recommended by millwork manufacturer to suit application.
 - 1. Contact adhesive cannot be water-based.
- B. Wall Adhesive: Solvent release cartridge type, compatible with substrate, capable of achieving durable bond.
- C. Bolts, Nuts, Washers, Lags, Pins, Nails, and Screws: Size and type to suite application.
- D. Fasteners: Size and type to suit application.
- E. **Hardware:**
 - 1. **Overlay Cabinet Hinges:** Fully concealed, self closing, heavy duty type, 135 degree opening, of type and weight to support door, US26 finish.
 - a. Blum Inc., #B71T555, 120 degree.
 - b. Grass America Inc., TEC 860 series.
 - c. Hardware Resources, 22855-3-000.
 - 2. **Cabinet Pulls:** Tubular pulls, brass or stainless steel with brushed chrome finish, length as appropriate. Confirm final lengths for each application during submittals phase with Design Architect.
 - a. **Basis of Design:** Hardware Resources, Naples Collection:
 - 1) **6 inch long:** 156SN; stainless steel tubular pull; 6 inches long; 7/16 inch diameter in satin nickel finish.
 - 2) **8 inch long:** 206SN; stainless steel tubular pull; 8 inches long; 7/16 inch diameter in satin nickel finish.
 - 3) **12 inch long:** 304SN; stainless steel tubular pull; 12 inches long; 7/16 inch diameter in satin nickel finish.
 - 4) **13 inch long:** 336SN stainless steel tubular pull; 13 inches long; 7/16 inch diameter in satin nickel finish.
 - 5) **14-1/2 inch long:** 368SN stainless steel tubular pull; 14-1/2 inches long; 7/16 inch diameter in satin nickel finish
 - 3. **Door Catches:** Aluminum encased, impregnated rubber magnet cabinet catch.
 - a. Stanley Hardware, # CD46.
 - b. Knappe & Vogt, # 916.
 - c. Hager Products, # 1439.
 - 4. **Full extension drawer slide:** Heavy duty model with self-lubrication frictionless, oilite bronze oil cushion bearings, rubber bumpers, tracks, mounting brackets, all zinc plated steel.
 - a. Accuride International, # 3640.
 - b. Knappe & Vogt, # 1483.
 - c. Hardware Resources, # 301FU series.
 - 5. **Shelf Supports Within Cabinets:** 5 mm diameter pin, for use in holes spaced at 1-1/4 inch o.c. vertically .
 - a. Knappe & Vogt, # 346 NP.
 - b. Hardware Resources, # 1707 BN.
 - 6. **Open Shelving:** Knappe & Vogt, 85/185 by width of shelves.
 - 7. **Grommets:** Round plastic wire access grommets, color to be selected by Architect, 2-inches clear opening diameter.
 - a. Doug Mocket Co., XG model.
 - b. Hardware Resources, 68000 series.
 - 8. **Shelf Standards at Display Cabinet:** Size as indicated on the Drawings, and finish as indicated in Document 008900 - Finish Selections Summary.
 - a. Extra Duty Standards: Knappe & Vogt, #85 Series.
 - b. Extra Duty Brackets: Knappe & Vogt, #185 Series.
 - c. Shelf Rests: Knappe & Vogt, #106.
 - d. Cushions: Knappe & Vogt, #129 RUB.

2.4 SHOP FABRICATION

- A. **Fabricate casework to AWI Custom Grade for plastic laminate covered work and Premium Grade for transparent finished work, with reveal overlay construction (or as indicated in AWI Architectural Casework Details if details are not present on Architect's Drawings).**
- B. **Identify components for proper grain matching during fabrication. Cut veneer faced material for drawers over doors from same sheet for vertical grain on each. Grain configuration and orientation shall match on drawers and doors of any one elevation and shall match other elevations within the same room or area.**
- C. Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and other fixtures. Verify locations of cutouts from site dimensions. Seal edge surfaces of cutouts.
- D. Before proceeding with millwork required to be fitted to other construction, obtain measurements and verify dimensions of shop drawings details for accurate fit.
- E. Sanding/Filling
 1. Perform work in accordance with AWI.
 2. Sand work smooth and set exposed nails and screws.
 3. Apply wood filler in exposed nail and screw indentations and leave ready to receive applied finishes.
 4. On items to receive transparent finishes, use wood filler which matches surrounding surfaces and of types recommended for applied finishes.
- F. **Prime seal concealed and semi-concealed surfaces. Brush apply only.**
- G. Fabricate casework to dimensions, profiles, and details shown.
- H. **Band exposed plywood edges with hardwood veneer to match front of surface veneer.**
- I. At curved sections, route and groove back of flat trim members, kerf backs of other wide flat members.
- J. Assemble casework in mill in as large of units as practicable to minimize field cutting and fitting.
- K. Miter trim joints, where required, by joining, splining, and gluing to complying with requirements for specified grade.
- L. On high pressure laminate work:
 1. Apply laminate finish in full, uninterrupted sheets of maximum practical lengths. Apply backing sheets to reverse side of items receiving laminate surfacing. Use white melamine for cabinet interiors.
 2. Form corners and butt joints with hairline joints.
 3. Do not locate joints within 2 feet of sink cut-out.
 4. Cap all exposed edges with laminate for counter tops, shelving, exposed interior parts, drawer and door fronts.
 5. **Apply white laminate Melamine backing sheet to interior of all base cabinets, wall cabinets, and drawers.**
 6. **All shelves in enclosed plastic laminate millwork shall be 3/4-inch plywood finished in white plastic laminate. (not melamine)**
- M. Construction:
 1. **General:**
 - a. Construct casework bodies, bottoms, dividers, sides, tops, shelves, doors, drawer fronts and countertops of 3/4 inch sheet material.
 - b. Use 1/2 inch thick solid lumber material for drawer sides, back and sub-front.
 - c. Use 5/16 inch thick tempered hardboard for drawer bottoms and cabinet backs.
 2. **Overlay Reveals:**
 - a. Unless shown or noted otherwise, allow 1/4 inch horizontal between adjacent drawers and doors and 1/8 inch at vertical edges.
 - b. Flush at top and bottom of wall cabinets and at bottom of base cabinets.
 3. **Methods of Joinery:**
 - a. Provide face plates, paneled ends, and construction, glued under pressure.
 - b. Provide body web frames of stile plowed and stub tenoned construction.
 - c. Join case body members by dado or concealed dowel joints.

- d. Do not use mechanical fasteners or metal clips for attachment of body members to other body members or to web frames.
- 4. **Base Cabinets:**
 - a. Use finished end panels unless condition will be fully concealed.
 - b. **Provide finished toe space fronts, finished to match cabinet front.**
 - c. Construct drawers with rabbited (tongue and groove) construction.
 - d. **Cover all interior components with white Melamine except shelving which shall be white laminate on 3/4-inch plywood.**
- 5. **Wall Cabinets:**
 - a. Use finished end panels unless condition will be fully concealed.
 - b. Provide continuous 1 by 3 inch anchor cleat at top and bottom of cabinet interior full width of unit. Secure cleat in rabbit over back, then glue and spot pin.
 - c. **Cover all interior components with white Melamine except shelving which shall be white laminate on 3/4-inch plywood.**
- 6. **Countertops:**
 - a. Provide with 1-1/2 inch deep face edge, faced with high pressure laminate unless noted or shown otherwise.
 - b. Provide loose 4 inch high pressure laminate covered splashes typically at countertops unless taller splashes shown or noted otherwise.
 - c. **Use marine grade plywood substrate for all countertops where sinks or water lines are present.**
 - d. Seal edge surface of all cut-outs in countertops.
- 7. **Shelving:**
 - a. 3/4 inch thick plywood or solid finish wood up to 36 inch unsupported length.
 - b. **1 inch thick for over 36 inch unsupported lengths (maximum 48").**

2.5 SHOP FINISHING

- A. **General: Finish all architectural cabinets at fabrication shop in a paint booth to furniture grade finish as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.**
- B. **Transparent Finish:**
 - 1. **Grade:** Premium.
 - 2. **Finish:** System - 2, precatalyzed lacquer.
 - 3. Wash coat helps prevent blotchiness with wiping stains.
 - 4. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to cabinets made from closed-grain wood before staining and finishing.
 - 5. **Staining:** Match Architect's sample.
 - 6. Filled Finish for Open-Grain Woods: After staining, apply wash-coat sealer and allow to dry. Apply paste wood filler and wipe off excess. Tint filler to match stained wood.
 - 7. **Sheen:** Semigloss, 46-60 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces openings and conditions are ready to receive work of this section. Notify Architect of any existing condition which will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.
- B. Verify that field measurements are as shown on shop drawings.
- C. Verify that mechanical, electrical, and other items affecting work of this section are in place and ready to receive the work.

3.2 PREPARATION

- A. Prime paint or seal concealed surfaces and items or assemblies which will be in contact with cementitious materials or surfaces.

- B. Make field cuts with extreme care to avoid splintering.

3.3 INSTALLATION

- A. **Install work in accordance with AWI Premium Quality Standards for stain grade work and Custom Quality Standards for plastic laminate work. Handle materials to avoid dents and other damages.**
- B. Set and secure materials and components, rigid, plumb, and square. Use joint fasteners to align and secure adjoining cabinets and countertops. Affix base cabinets to floor.
- C. Shim as required using concealed shims.
- D. Field Fitting
 1. Cut to fit and carefully scribe.
 2. Where casework abuts other finished work, scribe and cut for accurate fit.
 3. Where necessary to fit at site, provide ample allowance for cutting and fitting.
 4. Do not use overlay trim pieces to cover joints.
- E. Before making cutouts, drill pilot holes at corners.
- F. Distribute defects allowed in quality grade to best overall advantage when installing job assembled woodwork items.
- G. **Install trim and molding in unjointed lengths** for openings and for runs less than maximum length of lumber available. For longer runs, use only one piece less than maximum length available in straight run. **Allow no joints closer than 12 feet apart.**
- H. **Stagger joints in adjacent members.**
- I. Attach items securely in place with uniform joints providing for thermal and building movements; blind nail where possible.
- J. Use fine finishing nails where exposed.
- K. Set exposed heads for filling.
- L. Secure casework to anchors, built-in blocking, or directly attach to substrates where capable of adequately supporting load. Use toggle bolt type fasteners for wall mounted components. Secure countertops to base cabinets.
- M. Install hardware in accordance with manufacturer's recommendations.
- N. Cover exposed edges of sheet goods used for shelving and other items with veneer to match sheet goods unless otherwise noted.
- O. **On field applied laminate plastic work:**
 1. Apply plastic laminate finishes where indicated.
 2. Adhere with adhesive over entire surface. Make joints and corners hairline.
 3. Match patterns. Slightly bevel arises.
 4. Cap exposed edges with plastic laminate of same finish and pattern.
 5. **Apply laminate backing sheet on reverse side of plastic laminate finished surfaces.**
- P. Cope moldings at returns and miter at corners.
- Q. **Flush out end of countertops and backsplashes with end of base cabinets.**

3.4 ADJUSTING

- A. Adjust work under provisions of Section 017500.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.5 CLEANING/PROTECTION

- A. Protect casework from marring, defacement, or other damage until final completion.
- B. Clean spaces of debris and vacuum and wipe down casework. Leave in condition ready for use.

3.6 TOLERANCES FOR FIELD ASSEMBLIES/JOINED ITEMS

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/64 inch for plastic laminate countertops and splashes, 1/32 inch for other components.

END OF SECTION

SECTION 068213

GLASS FIBER REINFORCED PLASTIC PANELING

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
 - B. **Section Includes:**
 - 1. **Glass fiber reinforced plastic wall paneling at Janitor Closets and at other locations as indicated on Drawings.**
- 1.2 DELIVERY, STORAGE AND HANDLING
 - A. Deliver, store, handle, and protect products in accordance with Section 016000.
- 1.3 QUALITY ASSURANCE
 - A. **Manufacturer Qualifications:** Firm with **minimum 10 years experience specializing in manufacturer of glass reinforced panels.**
 - B. **Installer: Approved by manufacturer with 10 years experience** and having successfully completed five projects of similar scope and complexity.
- 1.4 SUBMITTALS
 - A. General: Submit in accordance with Section 007013 and Section 013100.
 - B. Submit **product data** describing physical and performance characteristics of each product and accessory proposed for use.
 - C. Submit actual **color samples** of full line of available colors for Architect's selection.

PART 2 - PRODUCTS

- 2.1 **ACCEPTABLE MANUFACTURERS:**
 - A. Crane Co. - Kemlite.
 - B. Marlite.
 - C. NUDO Products.
- 2.2 PRODUCTS
 - A. Fire Resistance Rating (per ASTM E-84):
 - 1. Flame Spread: Class A.
 - 2. Smoke Developed: 200.
 - B. Physical characteristics:
 - 1. Flexural strength: 15,000 psi.
 - 2. Tensile strength: 9,000 psi.
 - C. U.S.D.A. approved.
 - D. Thickness: 1/8", minimum, weighing 1-1/2 lbs/sq.ft.
 - E. **Color: Bright White.**
 - F. Adhesive: As recommended by manufacturer.
 - G. Accessories: Batten strips and related items as required and as recommended by manufacturer.
 - H. **Acceptable Products:**
 - 1. Fire-X Glasbord Plus, by Kemlite.
 - 2. Marlite FRP Panels, by Marlite.
 - 3. Fiber-Lite FRP Liner Panels, by NUDO Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready to receive work of this Section.
- B. Notify Architect of any existing conditions which will adversely affect execution.
- C. Beginning of execution will constitute acceptance of existing conditions.

3.2 PREPARATION

- A. Prepare substrate surfaces as recommended by manufacturer.

3.3 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturer's printed instructions and recommendations.

3.4 FIELD QUALITY CONTROL

- A. **Test for adhesion of in-place panels with suction cup used for glass installation.**

3.5 ADJUSTING

- A. Fasten or adhere for tight connections and joints.

3.6 CLEANING

- A. Perform final cleaning in accordance with Section 017700.

3.7 SCHEDULE

- A. Provide on all wall surfaces floor to ceiling in all Janitor and Custodial Closets.
- B. Provide at all other locations called for on drawings.

END OF SECTION

SECTION 071417
FLUID-APPLIED WATERPROOFING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. **Positive side fluid applied waterproofing system for elevator pits, below grade foundation walls above a finish floor, and other locations where a waterproof membrane is required below grade**
2. **Prefabricated drainage composite, protection board, or mat.**

1.2 SUBMITTALS

- A. **Product Data:** Submit manufacturer's product data, installation instructions, use limitations and recommendations.
- B. **Shop drawings:** showing locations and extent of waterproofing including details for terminations and flashings, projections, penetrations, drains and treatment of substrate joints and cracks.
- C. Written documentation demonstrating installers qualifications under the "Quality Assurance" article including reference projects of a similar scope.
- D. **Samples:** Submit minimum 12-inch by 12-inch representative samples of the following for approval:
 1. Fluid applied membrane.
 2. Prefabricated drainage composite board or mat.
- E. **Warranty:** Submit a sample warranty identifying the terms and conditions stated in Article 1.7.

1.3 QUALITY ASSURANCE

- A. **Manufacturer:** Waterproofing systems shall be manufactured and marketed by a firm with a **minimum of 20 years' experience** in the production and sales of waterproofing. The fluid applied composite sheet membrane waterproofing system must be supplied by single manufacturer. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.
- B. **Installer:** The installer shall demonstrate qualifications to perform the work of this Section by submitting the following:
 1. Certification or written license from the Waterproofing Manufacturer that the Installer is a trained applicator.
 2. **List of at least ten projects contracted within the past five years of similar scope and complexity to this project.**
 3. **At least 10 years' experience installing specified product** or similar type product
 4. Installer must show evidence of adequate equipment and trained field personnel to successfully complete the project in a timely manner.
 5. Installer's credentials must be approved by both the Architect and the Waterproofing Materials Manufacturer.
- C. **Materials:** Fluid applied composite sheet membrane waterproofing system shall be by single source manufacturer and shall consist of fluid applied waterproofing material, a two part synthetic rubber based system free of isocyanates and bitumen and a composite sheet, a three-layer co-extruded biaxially oriented HDPE integrally bonded to a non-woven geotextile. For each type of material required for the work of this section, provide primary materials that are the products of one manufacturer.
- D. **Pre-Installation Conference:** A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall

include review of surface preparation, minimum curing period, installation procedures, special details and flashings, inspection, testing, protection and repair procedures.

- E. **Inspection and Testing:** All areas shall be water tested following application and be inspected by an independent testing firm or individual trained and approved by the waterproofing systems manufacturer.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in the original, unopened containers with seals unbroken, labeled with the manufacturer's name, product brand name and type, date of manufacture and directions for storage and use.
- B. Store and handle materials in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.
 - 1. Do not double-stack pallets of waterproofing on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
 - 2. Store drainage composite or protection board flat and off the ground. Provide cover on top and all sides.
 - 3. Protect waterproofing materials from freezing.
 - 4. Store composite membrane. The composite membrane should be stored off the ground and not stacked more than 12 rolls high. Provide cover for material to protect top and sides
- C. Sequence deliveries to avoid delays, but minimize on-site storage.

1.5 PROJECT CONDITIONS

- A. **Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.**
- B. **Proceed with installation only when substrate construction and preparation work is complete and in condition to receive membrane waterproofing.**
- C. **Do not allow waste products (i.e. petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat, acids, etc.) to come into contact with the waterproofing membrane. Any exposure to foreign materials or chemical discharges must be presented to the Membrane Manufacturer to determine the impact on the waterproofing assembly performance.**
- D. **Horizontal Application - Concrete Deck Surface condition:**
 - 1. A minimum slope to drain of 11 mm/m (1/8 in./ft) shall be used on all concrete decks. This is best achieved with a monolithic structural slab and not with a separate concrete fill layer.
 - 2. Ensure no excessive deflection or movement of the deck or other structural problems.
 - 3. The deck shall provide for support of the maximum anticipated dead and environmental loads and for expansion and contraction suitable for the roof system structure.
 - 4. All projections, penetrations and openings in the deck should be completed before the waterproofing application begins.
 - 5. Joints in pre-cast/pre-stressed concrete decks are to be grouted so that the top surface is level and smooth before membrane application.
- E. **Deck/Wall Preparation: refer to Section 3.2 Substrate Preparation**
- F. **General contractor shall assure adequate protection and ventilation during the application of the Waterproofing assembly.**

1.6 WARRANTY

- A. Upon Project completion the contractor must submit a written warranty for the waterproofing materials signed by the Waterproofing Manufacturer.
- B. **Warranties** available from the manufacturer. Please see manufacturer specific written warranty documents for specifics (Choose one):
 - 1. **Watertightness Warranty:**

- a. **Manufacturer's standard 15-year watertightness warranty.**

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers and Products:

1. Carlisle; CCW-525.
2. W. R. Meadows; Hydralastic 836.
3. Tremco; TREMproof 250GC.

2.2 MATERIALS

- A. Fluid Applied Waterproofing Membranes:** One part, moisture-curing, rapid curing, high-solids, VOC-compliant modified polyurethane.
- B. Prefabricated Drainage Composite:** For all vertical surfaces. Drainage composite shall be designed to promote positive drainage while serving as a protection course.
- C. Miscellaneous Materials:** Tape and other accessories specified or acceptable to manufacturer of fluid applied waterproofing membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A.** The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 PREPARATION OF SUBSTRATES

- A. Vertical and Horizontal Surfaces:** Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be structurally sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods that are acceptable to manufacturer of the fluid applied waterproofing.
- B. Tie-holes and "bugholes" larger than 13 mm (1/2") in diameter or deeper than 3 mm (1/8"), or both,** should be repaired with a lean concrete mix or with a lean concrete mix or grout. See ASTM D 5295, Preparation of Concrete Surfaces for Adhered Membrane Waterproofing Systems, for further details on substrate preparation.
- C. Cracked, pitted, honeycombed or heavily bugholed surfaces** can be filled by spraying from close in (10" to 12") but high material usage will result. Under these circumstances it may be more efficient to fill the surface with a parge coat of lean mortar mix before application of the material. It is also acceptable to fill in gaps with a compatible sealant or caulk.
- D. Cast-In-Place Concrete Substrates:**
1. **For horizontal applications,** poured in-place concrete must be cast with a minimum slope to drain of 11 mm/m (1/8 in./ft.) and must be monolithic, smooth, and free of unapproved curing compounds, form release agents and other surface contaminants.
 2. Fill form tie rod holes with concrete and finish flush with surrounding surface.
 3. Repair bugholes over 13 mm (0.5 in.) in length and 6 mm (0.25 in.) deep and finish flush with surrounding surface.
 4. Remove scaling to sound, unaffected concrete and repair exposed area.
 5. Grind irregular construction joints to suitable flush surface.
- E. Pre-cast Concrete Decks:** All pre-cast units shall be mechanically fixed to minimize the potential for differential movement and all joints shall be grouted.
- F. Substrate Cleaning:**
1. Thoroughly sweep the substrate that is to receive the waterproofing membrane.
 2. Substrate must also be blown using oil free air to remove any remaining loose debris.

3. A final check to determine if the substrate is sufficiently clean is to apply a test patch of membrane and check its adhesion.

3.3 INSTALLATION

A. Refer to manufacturer's literature for recommendations on installation, including but not limited to, the following:

1. **Vertical Application Fluid Applied Membrane (Watertightness Warranty):**
 - a. **Detailing: Apply a minimum thickness of 1.5 mm (60 mils) over all detail areas** (including inside corners, outside corners, pipe penetrations, cracks, construction joints, etc) prior to application of the field of the membrane.
 - b. **Apply a minimum thickness of 2.3 mm (90 mils) over all vertical areas** to be waterproofed and lapping a minimum of 100 mm (4 in.) onto pre-treated detail areas. Perform wet film thickness tests as work progresses to confirm thickness.
2. **Horizontal Application Fluid Applied Membrane (15 year Watertightness Warranty):**
 - a. **Detailing:** Apply a minimum thickness of 1.5 mm (60 mils), or as per manufacturer's drawings and written application instructions, over all detail areas (including inside corners, outside corners, pipe penetrations, cracks, construction joints, etc) prior to application of the field of the membrane
 - b. Apply a minimum thickness of 1.5 mm (60 mils) over all horizontal areas to be waterproofed and lapping a minimum of 100 mm (4 in.) onto detail areas. Perform wet film thickness tests as work progresses to confirm thickness.
 - c. Apply a second coat at a minimum thickness of 1.5 mm (60 mils) over first coat and completely covering all detail areas to give a minimum total thickness of 3.0 mm (120 mils) in the field and 4.5 mm (180 mils) at detail areas. Perform wet film thickness tests as work progresses to confirm thickness.

B. Coat back of stone panels provided under Section 044300 - Exterior Stone Cladding that will be within 12 inches of grade.

3.4 WATER TEST

- A. Horizontal Applications:** All areas of horizontal decks must be water tested by means of electronic testing or ponding to a minimum depth of 50mm (2 in.) for a period of 24 hours to confirm the integrity of the membrane.
1. Allow the membrane to cure for a minimum period of 48 hours before starting water tests.
 2. Before flood testing, be sure the structure will withstand the dead load of the water.
 3. For well-sloped decks, segment the flood test to avoid deep water near drains.
- B. Mark any leaks and repair according to manufacturers repair procedures when the membrane is dry.**

3.5 CLEANING AND PROTECTION

- A. Remove any masking materials after installation. Clean any stains on materials that would be exposed in the completed work.
- B. A protection course should always be installed as soon as possible after completion of the waterproofing installation and flood testing to protect the membrane from mechanical damage and UV.
- C. Install any protection, drainage and insulation courses according to the manufacturer's instructions.

3.6 SCHEDULE

- A. Provide on exterior of all concrete foundation and walls below grade.
- B. Provide on exterior of elevator pits.

END OF SECTION

SECTION 071616

CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section includes crystalline negative side waterproofing for elevator pits.**

1.3 SUBMITTALS

- A. **Product Data:** For each type of product.
 - 1. Include construction details, material descriptions, and installation instructions.

1.4 QUALITY ASSURANCE

- A. **Applicator Qualifications:** A firm experienced in applying crystalline waterproofing similar in material, design, and extent to that indicated for this Project, whose work has resulted in applications with a record of successful in-service **performance with the specified product for a minimum of 10 years**, and that employs workers trained and approved by manufacturer.

1.5 FIELD CONDITIONS

- A. **Weather Limitations:** Proceed with application only when existing and forecasted weather conditions permit crystalline waterproofing to be performed according to manufacturer's written instructions.
- B. Proceed with waterproofing work only after pipe sleeves, vents, curbs, inserts, drains, and other projections through the substrate to be waterproofed have been completed. Proceed only after substrate defects, including honeycombs, voids, and cracks, have been repaired to provide a sound substrate free of forming materials, including reveal inserts.
- C. **Ambient Conditions:** Proceed with waterproofing work only if temperature is maintained at 40 deg F (4.4 deg C) or above during work and cure period, and space is well ventilated and kept free of water.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Xypex; Xypex Concentrate.

2.2 WATERPROOFING MATERIALS

- A. **Crystalline Waterproofing:** Prepackaged, gray-colored proprietary blend of portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and concrete unit masonry and reacts chemically with the byproducts of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate; with properties complying with or exceeding the criteria specified below.
 - 1. **Water Permeability:** Maximum zero for water at 30 feet (9 m) when tested according to COE CRD-C 48.
 - 2. **Compressive Strength:** Minimum 4000 psi (27.6 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.3 ACCESSORY MATERIALS

- A. **Patching Compound:** Factory-premixed cementitious repair mortar, crack filler, or sealant recommended by waterproofing manufacturer for filling and patching tie holes, honeycombs, reveals, and other imperfections; and compatible with substrate and other materials indicated.
- B. **Plugging Compound:** Factory-premixed cementitious compound with hydrophobic properties and recommended by waterproofing manufacturer; resistant to water and moisture but vapor permeable for all standard applications (vertical, overhead, and horizontal surfaces not exposed to vehicular traffic); and compatible with substrate and other materials indicated.
- C. **Water:** Potable.

2.4 MIXES

- A. **Crystalline Waterproofing:** Add prepackaged dry ingredients to water according to manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for suitable conditions where waterproofing is to be applied.
- B. Proceed with application only after unsatisfactory conditions have been corrected.
- C. Notify Architect in writing of active leaks or defects that would affect system performance.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions.
- B. Protect other work from damage caused by cleaning, preparation, and application of waterproofing. Provide temporary enclosure to confine spraying operation and to ensure adequate ambient temperatures and ventilation conditions for application.
- C. Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
- D. Stop active water leaks with plugging compound.
- E. Repair damaged or unsatisfactory substrate with patching compound.
 - 1. At holes and cracks 1/16 inch (1.6 mm) wide or larger in substrate, remove loosened chips and cut reveal with sides perpendicular to surface, not tapered, and minimum 1 inch (25 mm) deep. Fill reveal with patching compound flush with surface.
- F. **Surface Preparation:** Remove efflorescence, chalk, dust, dirt, mortar spatter, grease, oils, paint, curing compounds, and form-release agents to ensure that waterproofing bonds to surfaces.
 - 1. Clean concrete surfaces according to ASTM D 4258.
 - a. Scratch- and Float-Finished Concrete: Etch with 10 percent muriatic acid solution according to ASTM D 4260.
 - b. Smooth-Formed and Trowel-Finished Concrete: Prepare by mechanical abrading or abrasive-blast cleaning according to ASTM D 4259.
 - 2. Clean concrete unit masonry surfaces according to ASTM D 4261.
 - a. Lightweight Concrete Unit Masonry: Etch with 10 percent muriatic acid solution or abrade surface by wire brushing. Remove acid residue until pH readings of water after rinse are not more than 1.0 pH lower or 2.0 pH higher than pH of water before rinse.
 - b. Medium- and Normal-Weight Concrete Unit Masonry: Sandblast or bushhammer to a depth of 1/16 inch (1.6 mm).
 - 3. Concrete Joints: Clean reveals.

3.3 APPLICATION

- A. General: Comply with waterproofing manufacturer's written instructions for application and curing.

1. Saturate surface with water for several hours and maintain damp condition until applying waterproofing. Remove standing water.
 2. Apply waterproofing to surfaces.
 3. **Number of Coats: Two.**
 4. **Application Method:** Apply to ensure that each coat fills voids and is in full contact with substrate or previous coat.
 5. Dampen surface between coats.
- B. **Final Coat Finish:** Smooth.
- C. **Curing:** Moist-cure waterproofing for three days immediately after final coat has set, followed by air drying, unless otherwise recommended in writing by manufacturer.
- 3.4 FIELD QUALITY CONTROL
- A. **Manufacturer's Field Service: Engage a factory-authorized service representative to test** and inspect completed application of waterproofing.
- B. Prepare test and inspection reports.
- 3.5 **SCHEDULE**
- A. Provide on interior side of elevator pit walls.

END OF SECTION

SECTION 071823

FLOOR WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:** Waterproofing coatings for equipment-room and penthouse floors.

1.3 SUBMITTALS

- A. **Product Data:** For each type of product.
 - 1. Include installation instructions and details, material descriptions, dry or wet film thickness requirements, and finish.
- B. **Samples for Verification:** For each type of exposed finish, prepared on rigid backing.
 - 1. Provide stepped Samples on backing to illustrate buildup of coatings.
- C. **Maintenance Data:** For coatings to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An entity that employs installers and supervisors who are trained and approved by manufacturer with a **minimum of 10 years verifiable successful experience** with the approved product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:**
 - 1. **Manufacturer:** Tremco Commercial Sealants and Waterproofing.
 - 2. **Product:** Vulkem 350/950NF/950N.
 - 3. **Color:** As selected from full range of manufacturer's colors available.

2.2 COATING

- A. **Coating:** Manufacturer's standard, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for equipment-room floor; according to ASTM C 957.
- B. **Base Coat:** Single-components urethane membrane.
- C. **Intermediate Coat:** Two-component urethane membrane.
- D. **Topcoat:** Two-component urethane membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of coating work.
- B. Verify that substrates are visibly dry and free of moisture.
 - 1. Test for moisture content by measuring with an electronic moisture meter.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Begin coating application only after substrate construction and penetrating work have been completed.

2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by coating manufacturer has passed and after substrates are dry.
3. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by coating manufacturer.
- B. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.
- C. Concrete Substrates:
 1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
 2. Remove concrete fins, ridges, and other projections.
 3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
 4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

3.3 COATING APPLICATION

- A. Apply coating according to ASTM C 1127 and manufacturer's written instructions.
- B. Apply coats of specified compositions for each type of coating, at locations as indicated on Drawings, to wet film thickness recommended by manufacturer; turn up walls.
- C. Verify that wet-film thickness of each coat complies with requirements every 100 sq. ft.
- D. Apply coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.
- E. Cure coatings. Prevent contamination and damage during coating application and curing.

3.4 PROTECTING AND CLEANING

- A. Protect coatings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.5 SCHEDULE

- A. Provide on floors and 8" up perimeter walls of penthouse and first floor mechanical rooms at northeast corner of building including the following:
 1. Oxygen Storage 142.
 2. Dental Compressor and Vacuum 1 COMP.
 3. Fire Pump Room 1FIRE1.
 4. Equipment Room 1MECH1.
 5. Mechanical Penthouse 5MECH1.
 6. Elevator Controller Closet 5MECH2.

END OF SECTION

SECTION 072100

THERMAL BUILDING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Batt insulation in walls.**
- B. **Unfaced acoustical batt insulation.**
- C. **Blown-in acoustical insulation.**
- D. **Polyisocyanurate rigid insulation boards at exterior walls.**
- E. **Spray-applied cellulosic insulation.**
- F. **Installation accessories**

1.3 PERFORMANCE REQUIREMENTS

- A. Provide continuity of thermal barrier at building enclosure elements.
- B. Provide continuity of vapor and air barrier at building enclosure elements.

1.4 SUBMITTALS

- A. **Product Data:** Including performance specifications, composition, and applicable standards.
- B. **Manufacturer's Instructions:** Written installation instructions including attachment recommendations.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, handle, and protect products under provisions of Section 016000.
- B. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- C. Protect plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install insulation during inclement weather or when surfaces are moist.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate work in accordance with Section 013100.
- B. Do not begin work until substrate work is complete and work of other trades which will be concealed by work of this Section has been approved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers:** (See Articles below for specific products.)
 - 1. **Batt Insulation:**
 - a. Johns Manville.

- b. Owens Corning Fiberglas Corp.
- c. CertainTeed Corp.

2.2 THERMAL BATT INSULATION

A. Unfaced glass fiber composition minimum 1 pound per cubic foot density, meeting following standards:

1. ASTM E 84: Flame spread 25 maximum; smoke developed 50 maximum.
2. ASTM E 136: Non-combustible.
3. ASTM C 518: R value of 3.2 per inch of thickness.
4. ASTM C 665: Type I.
5. **Total Thickness:** As required to obtain R-value indicated, but **not less than R-19**.
6. **Acceptable Products:**
 - a. Unfaced Thermal Batt Insulation by Owens Corning Fiberglas Corp.
 - b. Unfaced Thermal Batt Insulation by CertainTeed Corp.
 - c. Unfaced Thermal-SHIELD by Johns Manville.

2.3 BATT (ACOUSTICAL) INSULATION

A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics:

1. **Thickness:** Refer to schedule at end of this Section.
2. Density: 1 pcf minimum.
3. **Acceptable Products:**
 - a. Sound Attenuation Batts by Owens Corning.
 - b. Sound Control Batts by CertainTeed.
 - c. Sound Control Batts by Johns Manville.

B. Unfaced, Mineral Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); unfaced mineral-fiber blanket insulation produced by combining mineral fibers of rock or slag with thermosetting resins; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics:

1. **Thickness:** Refer to schedule at end of this Section.
2. Density: 2.5 pcf minimum.
3. **Acceptable Manufacturers:**
 - a. Fibrex Insulations, Inc.
 - b. Rock Wool Manufacturing Co.
 - c. Roxul.
 - d. Thermafiber LLC.

2.4 RIGID BOARD INSULATION

A. Polyisocyanurate Board, Glass-Fiber-Mat Faced: ASTM C 1289, glass-fiber-mat faced, Type II, Class 2.

1. **Basis of Design:** Hunter Panels.
2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
3. **Thickness:** 1 inch., or as required to provide R-5.
4. **Acceptable Manufacturers:**
 - a. Atlas Roofing Corp.
 - b. Firestone Building Products.
 - c. Rmax, Inc.

B. Z Clips:

1. **Basis of Design:** Advanced Architectural Products; Smart ci Simple Z.
2. Sizes: As required to secure and bridge continuous insulation and to make attachment to Terra Cotta to flush out with brick.

2.5 ACCESSORIES

- A. **Joint Tape:** Pressure sensitive type, recommended by insulation manufacturer.
- B. **Insulation Adhesive:** Type recommended by board insulation manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrates and conditions are ready to receive work of this Section. Notify Architect and Owner of any existing conditions which will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.
- B. Verify that work of other trades which will be covered by insulation is complete and approved.

3.2 INSTALLATION

- A. Install batt insulation with mechanical fasteners at roof deck in accordance with manufacturer's recommendations after mechanical and electrical services have been installed.
- B. Fit batt insulation tight within stud spaces, above ceilings and tight to and behind mechanical and electric services within plane of insulation, leaving no gaps or voids. Butt insulation tightly. Cut and fit tightly around items penetrating insulation.
- C. Within stud or joist systems install full height and width in such manner that voids or openings do not occur. Insulation is required for full width between studs, including cavity of each stud. Do not allow insulation to obstruct vents.
- D. Cut and trim insulation neatly, to fit spaces. Cut insulation oversize to ensure tight butt joints when installed. Cut insulation to fit around protrusions and irregularly shaped projections. Use batts free of ripped backs or edges.
- E. Install sound blankets in stud cavities of walls and ceilings and elsewhere as detailed or scheduled. Butt tightly.
- F. **Do not tape joints of rigid insulation.**

3.3 PROTECTION

- A. **Protect insulation from moisture until building is made watertight.**

3.4 SCHEDULE

- A. Provide R values and thicknesses as follow unless specifically noted otherwise on the Drawings.
 - 1. **Continuous Insulation at Exterior Walls:** 3/4 inch thick, polyisocyanurate board.
 - 2. **Exterior Walls:** R-13, unfaced batts between studs, and 3/4 inch thick untapped rigid polyisocyanurate board applied outside of air barrier.
 - 3. **Penthouse Roof:** R-25 polyisocyanurate rigid insulation.
 - 4. **Roof:** Refer to following:
 - a. Section 075216 - Modified Bituminous Roofing.
 - 5. **Sound Batts at all Interior Stud Walls:** Full depth of stud cavity in all interior demising walls between rooms and in demising walls between rooms and corridors.
 - 6. **Sound Batts at all Interior Ceilings:** 4 inch sound batts above all ceilings where walls do not extend to deck above. Provide batts to nearest full-height walls which extend to deck.

END OF SECTION

SECTION 072423
DIRECT APPLIED FINISH SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. Section Includes: Direct-applied finish system (DAFS) and accessories indicated, specified, or required to complete application to soffits.

1.3 SUBMITTALS

- A. **Product Data:** Manufacturer's technical literature for each type of product indicated, specified, or required; include following:
1. Manufacturer's catalog number and general classification for each product.
 2. Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- B. **Samples for Verification:** 12 inch square sample prepared on rigid backing for each type of coating required.

1.4 QUALITY ASSURANCE

- A. **Applicator Qualifications:**
1. Experience: Company experienced with not less than 5 years' experience in performing specified work similar in design, products, and extent to scope of this Project; with:
 - a. A record of successful in-service performance.
 - b. Sufficient production capability, facilities, and trained and skilled personnel.
 2. Supervision: Maintain a competent supervisor who is at Project during times specified work is in progress, and, who is experienced in installing work similar in design, products, and extent to scope of this Project.
- B. **Field Samples:** Construct one field sample panel for each color and texture, illustrating surface finish, color and texture. Samples shall be of materials specified and of suitable size as required to accurately represent each color and texture used on the project. Prepare each sample using same tools and techniques for actual project application. Locate sample panel where directed and maintain and make available approved samples at the job site.

1.5 DELIVERY AND STORAGE

- A. **Delivery:** Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
- B. **Storage:** Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature recommended by manufacturer. Maintain storage containers in a clean condition, free of foreign materials and residue.

1.6 PROJECT CONDITIONS

- A. **Installation Ambient Air Temperature:** Minimum of 50°F and rising, and remain so for 24 hours prior to, during and after operations, until building heating system can maintain the above minimum temperature.
- B. **Substrate Temperature:** Do not apply materials to substrates whose temperature are below 50°F or contain frost or ice.
- C. **Inclement Weather:** Do not apply materials during inclement weather unless appropriate protection is employed.
- D. **Sunlight Exposure:** Avoid, when possible, installation of the materials in direct sunlight. Application of acrylic finishes in direct sunlight in hot weather may adversely affect aesthetics.

- E. Materials shall not be applied if ambient temperature exceeds 80°F or falls below 50°F within 24 hours of application. Protect materials from uneven and excessive evaporation during hot, dry weather.
- F. Prior to installation, the substrate shall be inspected for surface contamination, levelness or other defects that may adversely affect the performance of the materials and shall be free of residual moisture.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Contract Documents are based on products specified below to establish a standard of quality. Other available manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as judged by Architect.
 - 1. **Manufacturer:** Parex USA, Inc./Variance Specialty Finishes.
 - 2. **Components:**
 - a. **Primer:** VariPrime.
 - b. **Surface Leveler, Basecoat and Decorative Acrylic Finish:** Alto.

2.2 TRIM ACCESSORIES

- A. **J-Beads:**
 - 1. Product Description: Square edge trim for encasing edge of gypsum board.
 - 2. Material Quality Standard: ASTM A 653, G60, hot-dip galvanized zinc coating.
 - 3. Basis of Design: USG Corp.; J-Trim, 200-A.
- B. **Control Joints:**
 - 1. Product Description: One-piece trim formed with V-shaped slot, with removable strip covering slot opening.
 - 2. Material Quality Standard: ASTM B A 653, G60, hot-dip galvanized zinc coating.
 - 3. Basis of Design: USG Corp.; Control Joint, 093.
- C. **Screw Fasteners:**
 - 1. Product Quality Standard: ASTM C 1063.
 - 2. Description: Self-drilling and self-tapping screws with pan or wafer type head; fabricated from corrosive resistant or nonferrous metal; in lengths required to achieve minimum penetration of 3/8 inch beyond stud.

2.3 COMPONENTS

- A. **Gypsum Sheathing:** Glass-mat gypsum board specified in Division 06 Section "Gypsum Sheathing."
- B. **Primer:** 100% acrylic-based, vapor permeable, tintable primer designed to reduce variations in surface absorption, improve finish coverage, and improve consistency of finished aesthetics
- C. **Surface Leveler, Basecoat and Decorative Acrylic Finish:** Integrally colored, acrylic polymer based, trowel applied, multi-purpose basecoat and finish material designed for use with acrylic plaster finishing systems

2.4 MIXING

- A. General: Mix according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Acceptance of Surfaces and Conditions:
 - 1. Examine substrates to which direct-applied finish system (DAFS) will be applied for compliance with requirements and other conditions affecting performance.

2. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
3. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 PREPARATION

- A. **Treating Gypsum Sheathing Joints:** Apply three coats of drywall joint compound in conjunction with drywall tape. Fill and finish smooth. Wet sand/trowel filled joints, edges, corners, openings, and trim to produce surface ready to receive finish.

3.3 APPLICATION

- A. **Install according to ASTM C843 and manufacturer's instructions.**
- B. **Installing Accessories:**
 1. Attach accessories through sheathing with screw fasteners to hold in place and alignment; secure at ends and not more than 12 inches on centers.
 2. Maintain 1/4 inch between accessory and abutment to form a sealant joint.
 3. Install longest lengths possible, avoid butt joints.
 4. Install so that finish will be true to line, level, plumb, square, curved or as otherwise required, without excessive thickness of materials.
 5. Miter or cope at corners; install with tight joints seated with sealant and in alignment.
- C. **Applying Primer:**
 1. Apply primer over sheathing in a continuous coat to uniform thickness indicated by manufacturer instructions.
 2. Allow to dry before applying next coat.
- D. **Applying Basecoat:**
 1. Apply over primer to uniform thickness indicated by manufacturer instructions.
 2. Allow to dry before applying next coat.
- E. **Applying Decorative Acrylic Finish Coat:**
 1. Apply to basecoat when dry to uniform thickness indicated by manufacturer instructions.
 2. Apply by troweling with a stainless steel trowel.
 3. Apply finish coat in a continuous application, always working to a wet edge, and work to finish that matches approved submittals.
 4. Apply in a continuous application, and work a wet edge towards the unfinished wall area. Work to an architectural break in the soffit before stopping to avoid cold joints.

3.4 ADJUSTING

- A. **Imperfections:** Repair or replace work to eliminate cracks, dents, blisters, buckles, crazing, check cracking, dry outs, efflorescence, sweat outs, excessive pinholes, and similar imperfections and where bond to substrate has failed.

END OF SECTION

SECTION 072616
BELOW-GRADE VAPOR RETARDERS

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- 1.2 **SUMMARY**
 - A. Section includes:
 - 1. **Sheet materials for controlling vapor diffusion through concrete slabs.**
- 1.3 SUBMITTALS
 - A. General: Submit the following in accordance with provisions of Section 013300.
 - B. **Product Data:** Manufacturer's descriptive data and installation instructions for sheet vapor retarder and seaming tape.
 - C. **Samples for Verification:** Of sheet membrane, vapor barrier, 8 inches x 10 inches.
 - D. Test Reports: From independent laboratory indicating compliance with specified requirements by testing a single production roll according to ASTM E 1745, Section 8.
- 1.4 QUALITY ASSURANCE
 - A. **Installer Qualifications:** An experienced installer who is acceptable to manufacturer, who has completed applications similar in material and extent to that required for this Project, and whose work has resulted in construction with a record of successful in-service performance for a **minimum of 10 years.**
- 1.5 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials in original packages, bearing manufacturer's labels indicating brand name and directions for storage.
 - B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.
- 1.6 PROJECT CONDITIONS
 - A. Environmental Limitations: Comply with manufacturer's written recommendations for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting materials performance.
 - B. Close areas to traffic during installation and for time period after application recommended in writing by manufacturer.
- 1.7 COORDINATION
 - A. Coordinate placement of sheet vapor retarder with applicable Division 2 and 3 Sections.
 - B. Job Conditions: Do not install vapor retarder until all below-slab fill and utility work has been completed, tested, and backfilled.
 - C. Coordinate installation with scheduled concrete pours to avoid delays. Make provisions for installation of work by other trades.

PART 2 - PRODUCTS

- 2.1 **MANUFACTURER**
 - A. **Basis of Design:**
 - 1. Manufacturer: Stego Industries LLC.
 - 2. Sheet Vapor Retarder: Stego Wrap Vapor Barrier - 15 mil.

3. Accessories:
 - a. Seams: Stego Tape.
 - b. Penetrations of Vapor Retarder: Stego Mastic and Stego Tape.
 - c. Perimeter Edge Seal: Stego Crete Claw (one-sided seam tape not permitted).
 - d. Penetration Prevention: Stego Beast Foot.
 - e. Vapor Retarder-Safe Screed System: Stego Beast Screed.

2.2 MATERIALS

- A. Sheet Vapor Retarder:
 1. **Type: 15 mil** polyolefin film meeting requirements of ASTM E 1745, Class A.
 2. **Water Vapor Transmittance:** Maintain permeance of less than 0.01 perms [grains/(ft² x hr x inHg)] as tested according to ASTM E154, Sections 8, 11, 12, and 13 (ASTM E1745 Section 7.1 (7.1.1 – 7.1.5)).
 3. **Tensile Strength:** ASTM E 154; minimum 35.2 lbs/in, for new material.
 4. **Puncture Resistance:** ASTM D 1709, minimum 2400 grams.
 5. **Tear Resistance:** 7.40 pounds per foot MD per ASTM D 1004.
 6. **Other Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. **Type VP-1:**
 - 1) Stego Wrap Vapor Barrier 15 mil by Stego Industries, LLC.
 - 2) ~~Perminator 15 Mil~~, PMPC by W.R. Meadows.
 - 3) ~~Moistop Ultra 15 by Fortifiber Building Systems.~~
 - 4) Vaporguard by Reef Industries.
 - 5) Substitutions: None permitted.
 - b. **Type VP-2:**
 - 1) Stego Wrap Vapor Barrier 15 mil by Stego Industries, LLC. with Stego Crete Claw Tape at perimeters.
 - 2) Substitutions: None permitted.
- B. Accessories:
 1. **Seaming Tape:** Manufacturers standard multi-layer pressure-sensitive tape for sealing membrane joints and for sealing membrane to underside of concrete slab; 6 inches wide; water permeance property shall not exceed 0.03 perm according to ASTM F 1249 or ASTM E 96; provided by vapor retarder manufacturer.
 2. **Pipe Boot:** Use manufacturer's standard prefabricated pipe boots.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Do not proceed until under-slab plumbing and electrical rough-in work is complete, and specified fill or subgrade material has been placed, compacted, and tested; and is level and without voids.

3.2 INSTALLATION

- A. Place, protect, and repair vapor retarder sheets according to ASTM E 1643 and manufacturer's written instructions.
- B. For interior forming applications, avoid the use of non-permanent stakes driven through the vapor barrier. Use female-threaded screed pad posts with nail holes and insert them into Beast Foot. Ensure Beast Foot's peel-and-stick adhesive base is fully adhered to the vapor barrier.
- C. Use reinforcing bar supports with base sections that eliminate or minimize the potential for puncture of the vapor barrier.
- D. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
- E. Install under all concrete slabs on grade under structural slabs on carton forms and around all grade beams whether or not called for on Drawings.

- F. Install vapor retarder without tears, voids, and holes. Lap ends and edges as recommended by manufacturer, but not less than 6 inches over adjacent sheets. Seal laps with seaming tape.
 - G. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, waterstops, or any other site condition requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the slab itself using Stego Crete Claw, per manufacturer's instructions.
 - H. Turn sheet material down at grade beams.
 - I. Use manufacturer's prefabricated accessories around piping and other penetrations and fasten per manufacturer's instructions.
 - J. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required. Stagger end laps.
 - K. Install sheets continuously under grade beams.
 - L. Seal joints, tears, holes, perimeter, and penetrations through vapor with tape.
- 3.3 PROTECTION
- A. Do not permit unnecessary foot or vehicular traffic on unprotected horizontal membrane.
 - B. Protect completed membrane from damage. Prior to pouring concrete, inspect membrane for punctures or damage and repair as required to maintain vapor retarder integrity.
- 3.4 SCHEDULE
- A. **VP-1:** Provide under all slabs-on-grade conditions.
 - B. **VP-2:** Provide under all slab-on-carton forms at conditions between carton forms and slabs. Install according to manufacturer's recommendations.

END OF SECTION

SECTION 073213

CLAY ROOF TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. Clay Roof Tile.
- B. Fasteners.
- C. Underlayment.
- D. Flashings and Counterflashings.

1.3 DEFINITIONS

- A. Roofing Terminology: See ASTM D 1079, glossaries in TRI/WSRCA's "Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions," and NRCA's "NRCA Roofing and Waterproofing Manual" for definitions of terms related to roofing work in this Section.

1.4 SUBMITTALS

- A. **Product Data:** For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of clay roof tile and accessory.
 - 2. Manufacturer's printed installation instructions for each product, including product storage requirements.
- B. **Shop Drawings:**
 - 1. Clay Roof Tile:
 - a. Exposure Pattern.
 - b. Locations and configurations of special shapes.
 - c. Locations and configuration of each type of flashing.
 - 2. Fabricated Sheet Metal Items:
 - a. Dimensioned profiles.
 - b. Locations and extent of each item; include joint locations.
 - c. Jointing methods and materials.
 - d. Provisions for prevention or electrolytic action between dissimilar materials.
 - e. Interface with adjacent construction.
- C. **Samples for Verification:** Full-size field tile of each color and finish specified, representing the actual color and finish of products to be installed
- D. **Warranty:** Sample copy of standard manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.
- E. **Maintenance Data:** Maintenance letter issued by the clay roof tile manufacturer.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Company specializing in installing roofing of the type specified in this section, with no fewer than three years of documented experience.
- B. **Manufacturer Qualifications:** Current ISO 9000 certification.
- C. **Source Limitations:** Products specified in this section will be supplied by a single manufacturer, experienced in designing and manufacturing clay roof tile.
- D. **Mockups:**
 - 1. Construct mockup using materials specified in this section.
 - 2. Construct mockup as directed, at location indicated.

3. Obtain Architect/Owner's acceptance of mockup before beginning construction activities of this section; accepted mockup will be standard by which completed work of this section is judged.
 4. Accepted mockup may remain as part of Work.
- E. **Pre-Installation Meeting:**
1. Convene at job site prior to scheduled beginning of construction activities of this section to review requirements of this section.
 2. Require attendance by representatives of the following:
 - a. Roofing contractor of this section.
 - b. Other entities directly affecting, or affected by, construction activities or this section.
 3. Notify Architect and Owner four calendar days in advance of scheduled meeting date.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Store products of this in manufacturer's unopened packaging until installation.
 - B. Maintain storage area conditions for products of this section in accordance with the manufacturer's instructions until installation.
- 1.7 **WARRANTY**
- A. **Manufacturers Product Warranty:** Provide a 75-year warranty guaranteeing material integrity and color fastness for the clay roof tile.
 - B. **Roof Contractor Warranty:** The contractor warrants products of this section, as installed, to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for a period of 3 years.
- 1.8 **EXTRA MATERIALS**
- A. Provide an additional quantity of clay roof tile matching clay roof tile installed, in the amount of **3 percent of the total installed**, but not less than one full carton, for Owner's use in roof maintenance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturing facility shall be located in the United States of America:
- B. Manufacturer shall have been in continuous operation for over 100 years.
- C. Manufacturer shall be ISO 9000 certified and meet Cradle to Cradle specifications.
- D. Acceptable Clay Roof Tile Manufacturer: Ludowici Roof Tile; P.O. Box 69 4757 Tile Plant Road, New Lexington, OH 43764. Tel. (800) 945-8453. Email: info@ludowici.com. Website: www.ludowici.com.
- E. Requests for substitution will be considered in accordance with provisions of Section 016000.
- F. Unless otherwise specified for an individual product or material, supply all products specified in this section from the same manufacturer.

2.2 CLAY ROOF TILE

- A. **Clay Roof Tile, General:** Incombustible, vitrified tile manufactured from shale and fire clays, having less than 2.0 percent moisture absorption when tested in accordance with ASTM C 67, and meeting Grade 1 freeze/thaw resistance requirements when tested in accordance with ASTM C 1167.
 1. **Color Blend:** As indicated in Section 008900 - Finish Selection Summary.
- B. **Basis of Design Clay Roof Tile:** 13.25" Full Corner Spanish.
 1. **Profile:** A high profile tile with a simple one piece barrel design which provides a pattern of distinctive ripples across the roof.
 2. **Nominal Size:** 9.75 inches (247.6 mm) wide by 13.25 inches (336.6 mm) long.
 3. **Average Exposure:** 8.25 inches (209.6 mm) center to center by 10.25 inches (260.4 mm) long.

4. **Accessory Tile Pieces:** Provide any of the following pieces required for the work:
- a. 10.25" Full Corner Spanish Eave tile
 - b. 7.25" Full Corner Spanish Eave tile
 - c. Eave Closure tile
 - d. Top Fixture tile
 - e. End Band (Half) tile
 - f. Left Detached Gable Rake tile
 - g. Right Detached Gable Rake tile
 - h. Circular Cover Hip tile
 - i. Circular Cover Hip Starter tile
 - j. Circular Cover Ridge tile
 - k. Circular Cover Closed Ridge End tile
 - l. Circular Cover Hip/Ridge Terminal tile

2.3 ACCESSORY MATERIALS

- A. **Underlayment:** Ludowici Pro 70 over waterproofing membrane.
- B. **Waterproofing Membrane:** 40 mil minimum thickness ASTM D1970.
- C. **Flashing:** 16 oz / sq ft (0.56 mm) thick ASTM B 370 cold rolled copper.
- D. **Copper Wire:** 10 gauge (2.6 mm) minimum, with or without insulation.
- E. **Mortar for Finishing Valley Edges:**
 - 1. Mix the following materials in equal parts:
 - a. Factory-mixed mortar meeting requirements of ASTM C 387, Type M.
 - b. Factory-mixed surface bonding mortar meeting requirements of ASTM C 887.
 - 2. Add mineral oxide pigment to match color of roof tile.
 - 3. Add water and acrylic additive in accordance with mortar materials manufacturer's instructions to obtain correct mix for workability.
- F. **Roof Cement:** Asphalt roof cement conforming to ASTM D 4586, Type I or II
- G. **Sealant Used in Lieu of Flashing Cement:** ASTM C 920 silicone, provide one compatible with 3M 2-Component Roof Tile Adhesive AH-160 and underlayment.
- H. **Screws:** No. 8 or 9 brass or stainless steel, flathead phillips or square drive, of sufficient length to provide minimum 0.75 inch (19 mm) penetration into roof deck.
- I. **Nails for Solid Wood Deck:** Corrosion resistance copper or stainless steel; minimum 0.375 inch (9.5 mm) head diameter; shank minimum 11 gauge (3 mm), of sufficient length to provide minimum 0.75 inch (19 mm) penetration into roof deck but not through the underside.
- J. **Nails for Plywood Deck:** Slater's copper ring shank nail, 11 gauge (3 mm), of sufficient length to provide minimum 0.75 inch (19 mm) penetration into roof deck.
- K. **Wood Nailers and Cant Strips:** Preservative-treated wood, as specified in Section 061013.

2.4 FLASHING FABRICATION

- A. Flashing and Trim: Form to profiles indicated on drawings and as required to protect roofing materials from physical damage and shed water in accordance with manufacturer's instructions for indicated project conditions.
- B. Form sections square and accurate in profile, in maximum possible lengths, free from distortion or defects detrimental to appearance or performance.
- C. Fabrication of other indicated sheet metal items is specified in Section 076200.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that roofing penetrations and plumbing stacks are in place and properly flashed to deck surface.
- B. Verify that roof openings are correctly famed and of sufficient height to install required flashings.
- C. Verify that deck surfaces are dry and free of ridges, warps and voids.

3.2 PREPARATION

- A. Comply with clay roof tile manufacturer's recommendations on preparation of acceptable roof deck.
- B. Broom clean deck surfaces prior to installation of underlayment and prepare deck per the underlayment manufacturer's instructions.

3.3 UNDERLAYMENT AND ACCESSORY INSTALLATION

A. Underlayment:

- 1. Install per manufacturer's instructions.
- 2. Beginning at eave edge, install perpendicular to roof slope; extend minimum of 4 inches (100 mm) over gutters and valley flashing, and minimum 6 inches (150 mm) up abutting vertical surfaces.
- 3. Overlap side joints minimum 2-1/2 inches (64 mm); overlap end joints minimum 6 inches (150 mm).
- 4. Install second layer parallel to first layer, maintaining specified overlap at gutters, valley flashings, and at side and end joints; locate side joints minimum 18 inches (457 mm) from first layer side joints, and locate end joints minimum 12 inches (300 mm) from first layer end joints.
- 5. Fasten sides and ends to deck with fasteners spaced at maximum 6 inches (150 mm) on centers.
- 6. Install additional layer on rough surfaces; install additional layer of full-width high temp waterproof underlayment parallel to, and centered on, hips, ridges and valleys.

B. Flashings: Install at all locations where roof intersects side wall and head wall conditions.

C. Valley Flashings:

- 1. Install minimum 24 inch (610 mm) wide copper flashing over full-width high temp waterproofing membrane material; fasten metal to deck with cleats.
- 2. Overlap end joints minimum 12 inches (304.8 mm), do not solder joints.
- 3. Lap self-adhering waterproofing membrane material over edges of flashing 4 inches (101.6 mm).

D. Intersections of Roof Surfaces and Abutting Vertical Surfaces:

- 1. Install continuous 18 inch (457.2 mm) wide strips of high temp waterproof membrane material to extend 12 inches (304.8 mm) across roof deck and 6 inches (152.4 mm) up vertical surface.
- 2. Install continuous copper flashing to extend 4 inches (101.6 mm) up vertical surface.
- 3. Form saddle flashings for protrusions through roof in accordance with manufacturer's instructions.

E. Fabricate Sheet Metal Items: Install in accordance with shop drawings and SMACNA ASMM.

3.4 CLAY ROOF TILE INSTALLATION

- A. Install tile roofing in strict accordance with manufacturer's instructions.
- B. Install the Eave Closure tile flush with eave.
- C. Install the first course of field tile over Eave Closure tile overhand of first course of field tile at eave should not be less than 0.75 inches (19 mm) and not more than 2 inches (51 mm). This dimension should be related to the size of the gutters and should either be shown on the drawings or specified here.
 - 1. Do not drive fasteners tightly against tiles, to reduce risk of breakage and to allow for natural deck movement.
 - 2. Allow tile to "hang" on its fasteners.
- D. Alternate installation of the tile at the eave beginning with 13.25" Full Corner Spanish tile, 10.25" Full Corner Spanish tile, 7.25" Full Corner Spanish tile. Repeat sequence along the entire eave.
- E. All subsequent courses above the eave will utilize 12.25" Full Corner Spanish tile.
- F. Install each subsequent course with a maximum exposure in each course of 10.25 inches (260.4 mm). Wet cut tile at hips and valleys, using masonry saw with diamond blade.
- G. At hip and ridge install bead of adhesive at butt edge of each tile of sufficient thickness to ensure adhesion between tiles and located so it is completely concealed. Install sealant as

required at hip and ridge accessories to achieve watertight installation. Install type M mortar between cut field tile and nailer for hip tile.

3.5 PROTECTION

- A. Do not permit traffic over finished roof surface unless absolutely necessary.
- B. Minimize traffic over installed clay roof tile. If necessary, wear soft-soles shoes and walk on the "butt" edge of the tile in order to avoid breakage.
- C. Replace tile broken due to improper protection or traffic control.

END OF SECTION

SECTION 074213

METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:**

- 1. **Exposed-fastener, lap-seam metal wall panels.**

1.3 SUBMITTALS

- A. **Product Data:** For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

- B. **Shop Drawings:**

- 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

- C. **Samples for Initial Selection:** For each type of metal panel indicated with factory-applied finishes.

- 1. Include Samples of trim and accessories involving color selection.

- D. **Samples for Verification:** For each type of exposed finish, prepared on Samples of size indicated below:

- 1. **Metal Panels:** 36 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

- E. **Sample Warranties:** For special warranties.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An entity that employs installers and supervisors who are trained and approved by manufacturer with a **successful track record of installing specified product for over 10 years.**

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.6 FIELD CONDITIONS

- A. **Weather Limitations:** Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.7 WARRANTY

- A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. **Warranty Period: Two years** from date of Substantial Completion.
- B. **Special Warranty on Panel Finishes:** Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. **Finish Warranty Period: 20 years** from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. **Basis of Design:** As indicated in Section 008900 - Finish Selections Summary.

2.2 PERFORMANCE REQUIREMENTS

- A. **Structural Performance:** Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 1. **Wind Loads:** As indicated on Drawings.
 - 2. **Deflection Limits:** For wind loads, no greater than 1/240 of the span.
- B. **Thermal Movements:** Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. **Temperature Change (Range):** 120 deg F, ambient; 180 deg F, material surfaces.

2.3 EXPOSED-FASTENER, LAP-SEAM METAL WALL PANELS

- A. General: Provide factory-formed metal panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weathertight installation.
- B. **Perforated, Corrugated-Profile, Exposed-Fastener Metal Wall Panels:** Formed with alternating curved ribs spaced at 2.67 inches o.c. across width of panel.
 - 1. **Metallic-Coated Steel Sheet:** Zinc-coated (galvanized) steel sheet complying with ASTM A 653, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755.
 - a. Nominal Thickness: 0.022 inch.
 - b. Exterior Finish: Two-coat fluoropolymer.
 - c. Color: White.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653, G90 (hot-dip galvanized) coating designation or ASTM A 792, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system. Match material and finish of metal panels unless otherwise indicated.

- C. **Flashing and Trim:** Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
 - D. **Panel Fasteners:** Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
 - E. **Panel Sealants:** Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. **Butyl-Rubber-Based, Solvent-Release Sealant:** ASTM C 1311.
- 2.5 **FABRICATION**
- A. **General:** Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
 - B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
 - C. **Sheet Metal Flashing and Trim:** Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
- 2.6 **FINISHES**
- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - B. **Steel Panels and Accessories:**
 - 1. **Two-Coat Fluoropolymer:** AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. **Color:** Refer to Section 008900 - Finish Selections Summary.

PART 3 - EXECUTION

- 3.1 **EXAMINATION**
- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
 - B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
 - C. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 **PREPARATION**
- A. **Miscellaneous Supports:** Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
- B. **Fasteners: Use stainless-steel fasteners** for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. **Metal Protection:** Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. **Lap-Seam Metal Panels:** Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
 - 1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
 - 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 - 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 - 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
 - 5. Flash and seal panels with weather closures at perimeter of all openings.
- E. **Accessory Installation:** Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- F. **Flashing and Trim:** Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
 - 1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
- G. **Watertight Installation:**
 - 1. Apply a continuous ribbon of sealant to seal lapped joints of metal panels, using sealant as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
 - 2. Provide sealant between panels and protruding equipment, vents, and accessories.
 - 3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 074244

COMPOSITE ALUMINUM WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section Includes:

1. Prefinished, composite aluminum panels, in compliance with the fire hazard classifications as required by IBC 2006 and NFPA 285.
2. Extruded aluminum mounting system.
 - a. System summary: drained/back-ventilated, rout-and-return, aluminum composite panel rainscreen system, modeled in compliance with the insulation requirements of IECC, fabricated by a Premium MCM Fabricator, or equivalently qualified, as defined by the Metal Construction Association.

1.3 SYSTEM DESCRIPTION

A. System Requirements:

1. **Exterior - Rainscreen System:** Panel system utilizing aluminum extrusion with integral concealed support system. No field sealant, gasketing, exposed flashing or trim required (coping required at parapet conditions). **System requires a geographically-suitable air barrier over sheathing back-up.** Trades responsible for penetrations through air barrier will seal penetrations according to membrane manufacturer's recommendations.
2. **Interior - Standard Mounting:** Fabricator's standard aluminum extrusion mounting system.

B. Delegated Design Requirements:

1. **Fabricator:** Responsible for designing system, including anchorage to structural system and necessary modifications to meet specified requirements and maintain visual design concepts.
 - a. **Employ registered professional engineer,** licensed to practice structural engineering in Texas, to certify compliance with system performance requirements.
 - b. **Drawings:** Diagrammatic and are intended to establish basic dimension of units, sight lines, and profiles of units.
 - c. **Provide concealed fastening.**
 - d. **Attachment Considerations:** Account for site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening and fracturing connections.

C. Performance Requirements: Certify compliance with requirements listed below, based on manufacturer's test data for testing conducted by independent laboratory. Laboratory results older than eight (8) years from date of submittal shall not be acceptable. If current test results are unavailable or unacceptable, conduct testing to certify compliance, without impact to the construction schedule.

1. **Maximum Perimeter Framing Deflection:** Normal to plane of wall between supports, deflection of secured perimeter framing members shall not exceed L/175 or 3/4 inch, whichever is less.
2. **Maximum Panel Deflection:** Not exceed L/60 of full span normal to plane of wall.
3. **Maximum Anchor Deflection:** Not exceed 1/16 inch.
4. **Maximum Permanent Deflection of Framing Members:** Not exceed L/100 of span length at 1-1/2 times design pressure and components shall not experience failure or gross permanent distortion. At connection points of framing members to anchors, permanent set shall not exceed 1/16 inch.

5. **Air infiltration: not to exceed 0.04cfm per square foot** of wall specimen area, when tested to 6.24psf in accordance with ASTM E283.
6. **Static water infiltration: no uncontrolled water shall pass into the room-side of the wall assembly when tested at a differential static pressure of 15psf** in accordance with ASTM E331.
7. **Bond Integrity:** When tested for bond integrity, ASTM D1781 (simulating resistance to panel delamination), there shall be no adhesive failure of bond between core and skin nor cohesive failure within core, based on following values.
 - a. **Bond Strength:** 214 PSI (Vertical Pull)
 - b. **Peel Strength:**
 - 1) 22.5 inch pound/inch dry.
 - 2) 22.5 inch pound/inch after 8 hours in water at 200° F.
 - 3) 22.5 inch pound/inch after 21 days soaking in water at 70° F.
- D. **Structural Performance:** Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
 1. **Design Wind Loads:** As indicated on structural drawings.
 2. **Deflection Limits:** Metal-faced composite wall panel assemblies shall withstand wind loads with deflections in compliance with paragraph 1.2C.
- E. **Thermal Movements:** Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. **Temperature Change (Range):** Minus 29 to plus 82 deg C ambient; 180 deg F 100 deg C material surfaces.
- F. **Interface With Adjacent Systems:**
 1. Accommodate allowable tolerances and deflections for structural members in installation.
 2. Attachments of panel support system are to be to minimum 16 gauge metal stud system.

1.4 SUBMITTALS

- A. **Product Data:** Submit following:
 1. Product data for entire system, including panels, concealed flashings, and finishes.
 2. Color charts for finish indicating manufacturer's colors available for selection.
 3. Samples of warranties customized for this project.
- B. **Shop Drawings:** Submit for installation of system, including panel fabrication, jointing, corners, concealed flashings, gutters, weeps, copings, fascia, soffits, and accessories.
 1. Stamp with seal and signature of professional engineer responsible for design.
 2. Submit detail drawings of panel connections, draining, ventilating and weep details.
 3. Indicate details for sheathing and metal stud system support for the panel system.
 4. Detail connections, fastener penetrations through air barrier, method and materials used to seal penetrations.
 5. Include transitions and interfacing with all surrounding fenestration products or adjacent construction.
 6. Indicate how trim members are spliced, sealed, terminate and provide water tight conditions with fenestration products and surrounding conditions.
 7. Indicate the sheathing and air barrier terminate, interface and seal to fenestration products and surrounding conditions to make water tight installation.
 8. Submit R-value averaging of proposed wall assembly, in compliance with the insulation requirements for steel-framed walls as determined by IECC 2009 table 502.1.2. Model design criteria should match ASTM E283 test specimen in size and detailing.
- C. **Samples: Submit minimum 12 by 12 inch in size** illustrating composition and color. Draw-down lines are only acceptable for new custom formulations.
- D. **Informational Submittals:** Submit following packaged separately from other submittals:
 1. Design data for system indicating compliance with delegated design requirements.
 2. Test Reports: Certified test reports showing compliance with performance requirements.

3. Certifications specified in Quality Assurance article.
 4. Qualification Data: All required qualification data.
 5. Fabricator instructions.
 6. Manufacturer's field reports.
- E. **Closeout Submittals:** Submit warranty in accordance with Section 017700.

1.5 QUALITY ASSURANCE

- A. **Engineer Qualifications:** **Registered professional engineer** licensed to practice structural engineering in Texas, with minimum of five years' experience in design of metal wall systems and structural stud design.
- B. **Manufacturer Qualifications:** Company specializing in manufacturing Products specified in this Section with **minimum 20 years' experience**.
- C. **Fabricator Qualifications:** Company specializing in fabricating work specified in this Section with **minimum 10 years' experience**. Fabricator shall be a certified as a Premium MCM Fabricator, or equivalently qualified, by Metal Construction Association Fabricator's Council, and shall be preauthorized by aluminum-faced composite panel manufacturer. Fabricator shall document 10 projects of similar nature in past five years. Fabricator shall demonstrate ability to comply with section 3.1B below. All material measurements to be verified in field.
- D. **Installer Qualifications:** Certified acceptable to fabricator, with experience on at least **10 projects of similar nature in past five years**.
- E. **Certifications:**
1. Fabricator's certification that Installer is approved to perform work.
 2. Fabricator's certification that products furnished for Project meet or exceed specified requirements.
 3. Engineer's Certifications.
- F. **Pre-installation Conference:** Conduct conference at project site to review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
1. Panel fabricator/installer shall meet with Owner, Architect, Composite Material Manufacturer's Representative, and other trade Contractors whose work interfaces with or affects metal wall panels including installers of doors, windows, and louvers. A direct employee of the fabricator must be present at the conference.
 2. Review and finalize construction schedule and verify availability of materials, fabricator/installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 5. Review flashings, special details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
 6. Review governing regulation and requirements for insurance, certificates, and testing and inspecting if applicable.
 7. Review temporary protection requirements for metal wall panel assembly during and after installation.
 8. Review wall panel observation and repair procedures after metal wall panel installation.
 9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 FIELD MOCK-UPS

- A. Sample Exterior Installation:
1. Construct on-site mock-up **10 feet long by 10 feet tall** as directed.
 2. Show jointing, corners, weeps, and typical construction techniques.
 3. **Accepted Field Sample: May remain part of completed Work.**

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading: Protect finish panel faces, including plastic sheet protection wrap.
- B. Acceptance at Site: Inspect each panel and accessory as delivered and confirm that finish is undamaged. Do not install damaged panels.
- C. Storage and Protection: Comply with fabricator's printed requirements.

1.8 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with manufacturer's written requirements under which products can be installed.

1.9 WARRANTY

- A. **Special Warranties:** Prepare and submit in accordance with Section 017800.
 - 1. **Factory Finish: 30-year Warranty** Stating Finish will be:
 - a. Free of fading or color change in excess of 5 Delta E units, ASTM D2244;
 - b. Will not chalk in excess of numeral rating of 8 for colors and 6 for whites, ASTM D4214;
 - 2. **Fabricator/Installer Warranty:** Standard form in which Fabricator agrees to repair or replace metal panels that fail due to improper fabrication or installation techniques:
 - a. **Warranty Period: One year** from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers:**
 - 1. Alpolic, Mitsubishi Plastics Composites America, Inc., Chesapeake, VA 23320
 - 2. Alucobond, manufactured by 3A Composites USA, Inc., Benton, KY 42025.
 - 3. Reynobond, Alcoa Architectural Products, Eastman GA 31023.
 - 4. Substitutions: Manufacturer shall document 1 million square feet of successful product installation on domestic projects, compliant with quality assurance, testing, and performance requirements specified herein. Document full compliance with IBC 2006 and ICC-ES Acceptance Criteria 25.

2.2 ACCEPTABLE FABRICATORS

- A. **Basis of Design:**
 - 1. Acceptable Fabricators:
 - a. EWS.
 - b. NOW Specialties Inc., Carrollton, TX 75006.
 - 2. Exterior and Interior System: 4100 System.

2.3 MATERIALS

- A. **Composite Panels:**
 - 1. Aluminum-faced panel with thermoplastic core.
 - a. Overall Panel thickness: 0.157 inches.
 - b. **Aluminum Face:** 0.0197 inches, with strippable protective film. Protective film: heavy and opaque if required to indicate finish grain direction.
 - c. **Aluminum Backer Sheet thickness:** 0.0197 inches.
 - d. **Aluminum Alloy:** ASTM B209 3003 at coated finish.
- B. **Composition: Two sheets of aluminum sandwiching core of extruded thermoplastic material formed in continuous process** with no glues or adhesives between dissimilar materials. Products laminated sheet by sheet or in batch process using glues or adhesives between materials shall not be acceptable.
 - 1. **Standard Polyethylene Core** (where permitted by IBC 2006 or applicable codes), with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing agency acceptable to authorities having jurisdiction:

- a. Flame-Spread Index: 25 or less
 - b. Smoke-Developed Index: 450 or less
- 2. **Fire-Retardant Core (where required by IBC 2006 or other applicable code):** Complies with NFPA 285, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - a. Flame-Spread Index: 15 or less.
 - b. Smoke-Developed Index: 105 or less.

2.4 MISCELLANEOUS METAL FRAMING

- A. **Miscellaneous Metal Framing, General:** ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 Z120 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.
- B. **Subgirts:** As required by structural calculations. Minimum requirement is manufacturer's standard C- or Z-shaped sections 0.079-inch nominal thickness.
- C. **Zee Clips:** As required by structural calculations. Minimum requirement is 0.079-inch nominal thickness.
- D. **Base or Sill Angles:** As required by structural calculations. Minimum requirement is 0.079-inch nominal thickness.
- E. **Hat-Shaped, Rigid Furring Channels:**
 - 1. Nominal Thickness: As required by structural calculations. Minimum requirement is as required to meet performance requirements.
 - 2. Depth: 7/8 inch.
- F. **Cold-Rolled Furring Channels:** As required by structural calculations. Minimum requirement is minimum 1/2-inch wide flange.
 - 1. Nominal Thickness: As required by structural calculations. Minimum requirement is as required to meet performance requirements.
 - 2. Depth: 3/4 inch.
 - 3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.079-inch.
 - 4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.
- G. **Fasteners for Miscellaneous Metal Framing:** As required by structural calculations. Minimum requirement is of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.5 ACCESSORIES

- A. **Panel Extrusions:** Extruded aluminum, ASTM B 221.
- B. **Concealed Flashings:** Formed aluminum sheet, minimum 0.030 inch, ASTM B 209, post-finished to match panels.
- C. **Stiffeners:** formed of extruded aluminum, adhered to interior side of metal wall panel with structural silicone and VHB tape, and designed to tie-in to extrusions. Spacing: single, full-width span per every 19.99 square feet of panel area. Demonstrate compliance with structural review and IBC 2006: in event of a contradiction, more stringent requirement will govern. No alternate type stiffeners shall be permitted, such as galvanized steel angles, plates, subgirt or aluminum composite material.
- D. **Escutcheon plates:** 2" thick, or as directed by architect. Plates: fabricated from the same sheet stock and batch as the face material. Hem outside edge to conceal material core. Maintain 1/16-inch joint between inside edge and adjacent material.

2.6 FABRICATION

- A. **General:** Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by fabricator's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

- B. Fabricate metal-faced composite wall panels in a manner that allows proper ventilation on interior side of panel.
- C. **Metal-Faced Composite Wall Panels:** Factory form panels in a continuous process with no glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.
 - 1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle. Exposed gaps or pinholes will not be acceptable.
 - 2. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or VHB tape.
 - 3. Fabricate material as necessary to install all panels with finish grain direction arrows oriented as shown on approved shop drawings.
 - 4. **Dimensional Tolerances:**
 - a. **Length:** Plus or minus 1/16 inch.
 - b. **Width:** Plus or minus 1/16 inch.
 - c. **Thickness:** Plus or minus 0.008 inch.
 - d. **Panel Bow:** 0.8 percent maximum of panel length or width.
 - e. **Squareness:** 1/16 inch maximum.
- D. **Sheet Metal Accessories:** Fabricate concealed flashings to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. **Sealed Joints:** Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal-faced composite wall panel manufacturer.
 - a. **Size:** As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal-faced composite wall panel manufacturer for application, but not less than thickness of metal being secured.
- E. **Exterior System Characteristics:**
 - 1. **Concealed fastener, drained/back-ventilated rainscreen principle.**
 - 2. **Weight:** 1.62 pounds per square foot.
 - 3. **Pan depth:** 1 inch, formed out of 1" route-and-return perimeter panel legs.
 - 4. **System depth (dimension from exterior face of panel to air barrier):** 2 1/4 inch.
 - 5. **Horizontal joint:** open to inner leaf. Continuous, extruded horizontal track, with extruded clip attachment. Exposed fasteners within the joint will not be acceptable.
 - 6. **Vertical joint:** open to inner leaf. Clip profile: anchored to vertical I-beam stiffener. Exposed fasteners within the joint will not be acceptable.
 - 7. **Base detail:** open to inner leaf. Continuous, extruded horizontal track, with extruded clip attachment. Concealed base flashing: controls bulk water and condensation by shedding moisture to the outside of the building. Allow 8 inches of vertical clearance between base of panel and landscaping. Grade must allow proper drainage of ground water. Submersion of panel system or any other components of the wall assembly shall not be permitted. Exposed fasteners within the joint will not be acceptable.
 - 8. **Top detail:** coping material shall be offset 1/4-inch from face of material to allow for proper ventilation. Exposed fasteners within the joint will not be acceptable.

2.7 FINISH

- A. Coil-coated, 30% maximum gloss **70% Kynar 500 or Hylar 5000-based polyvinylidene fluoride (PVDF) resin** in conformance with AAMA 605-05. Finishes formulated from Lumaflon resins such as Megaflon and Coraflon shall not be acceptable.

1. **Acceptable Color:** Color to be selected from manufacturer's full and complete line of architectural finishes. Refer to Section 008900 - Finish Selection Summary

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Fabricator present, for compliance with requirements for installation tolerances, metal-faced composite wall panel supports, and other conditions as shown on reviewed and accepted shop drawings for conditions affecting performance of the Work.
 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal-faced composite wall panel manufacturer.
 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal-faced composite wall panel manufacturer.
 3. Verify that weather-resistant membrane has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Fabricator shall field-verify all material measurements prior to fabrication. Measurements shall have no impact to the construction schedule. Communicate to the Architect if material measurements will impact the design intent.
- C. Examine roughing-in for components and systems penetrating metal-faced composite wall panels to verify actual locations of penetrations relative to panel joint locations of panels before panel installation.
- D. Prepare written report, endorsed by Fabricator, listing conditions detrimental to performance of the Work, and issue to Architect as formal submittal.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Miscellaneous Framing:** Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and structural engineer's written instructions. Confirm that all penetrations through the air barrier have been sealed.

3.3 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

- A. General: Install metal-faced composite wall panels according to Fabricator's written instructions in orientation, sizes, and locations indicated on Drawings. Install panel's perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place to the structural studs, with provisions for thermal and structural movement.
 1. Commence metal-faced composite wall panel installation and install minimum of 300 sq. ft. in presence of Fabricator's general superintendent or authorized representative.
 2. Install all panels with finish grain direction arrows oriented as shown on approved shop drawings.
 3. Flash metal-faced composite wall panels at perimeter of all openings. Do not begin installation until air barrier and flashings that will be concealed by panels are installed, properly sealed and tested for water tightness and conditions inspected and accepted by independent inspector before being concealed by the panel system.
 4. Install flashing and trim as metal-faced composite wall panel work proceeds.
 5. Provide aesthetic escutcheons for pipe and conduit penetrating the air barrier and exterior walls.
- B. **Fasteners:**
 1. **Aluminum Wall Panels:** Use **stainless-steel fasteners** for attachment of the girts and subgirts.
- C. **Metal Protection:** Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.

- D. **Attachment System Installation, General:** Install attachment system required to support metal-faced composite wall panels and to provide a complete system per contract documents, including subgirts, extrusions, tracks, panel clips, and anchor channels.
 - 1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery.
 - 2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.
- E. **Drained/Back-Ventilated Installation:** Provide fabricator's standard track, clips, and stiffeners for a complete outer leaf, draining to the exterior at base. Install support system at locations and, spacing, required by structural engineer. Attach wall panels by interlocking extruded clips attached to stiffeners within routed-and-turned flanges of wall panels.
 - 1. Install wall panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
 - 2. Do not apply sealants to joints unless otherwise indicated on Drawings.

3.4 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal-faced composite wall panel assembly including corners, concealed flashings, baffles, gussets, closure strips, and similar items.
- B. Flashing: Comply with performance requirements, Fabricator's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install concealed flashing free of visible oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Expansion Provisions: Provide for thermal expansion of concealed flashing. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep.

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, non-cumulative, on level, plumb, location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service: Engage authorized service representative to inspect,** observe testing, and adjust completed metal-faced composite wall panel installation, including accessories **at pre-installation, mid-point of installation, and finished installation.**
- B. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. **Prepare test and inspection reports and submitted to Architect within 7 days.**

3.7 CLEANING

- A. Remove temporary protective coverings and strippable films as metal-faced composite wall panels are installed unless otherwise indicated in manufacturers written installation instructions. Maintain in original condition after installation and document damage by other trades.
- B. After metal-faced composite wall panel installation, clear weep holes of obstructions and dirt.
- C. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 075400
THERMOPLASTIC MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. Section Includes:
1. Adhered thermoplastic polyolefin (TPO) membrane roofing systems.
 2. Roof insulation.

1.3 PERFORMANCE REQUIREMENTS

- A. **General Performance:**
1. Installed membrane roofing shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without water penetration or failure due to defective manufacture, fabrication, installation, or other defects in construction.
 2. Membrane roofing and base flashings shall remain watertight.
- B. **Roofing System Design:** Membrane roofing identical to systems successfully tested by a qualified testing and inspecting agency to resist uplift pressure.
- C. **FM Approvals Listing:**
1. System Quality Standards: Membrane roofing, base flashings, and accessories complying with following requirements:
 - a. FM Approvals 4450.
 - b. FM Approvals 4470.
 2. Fire/Windstorm Classification: Class 1-75.
 3. Hail Resistance: SH.

1.4 SUBMITTALS

- A. **Product Data:** Manufacturer's technical literature for each product indicated, specified, or required.
1. Include manufacturer's written installation application instructions.
 2. Include material descriptions, individual components, profiles, accessories, and finishes.
 3. Include manufacturer's written instructions for evaluating, preparing, and treating substrate onto which work will be applied.
 4. Include manufacturer's standard drawing details recommended for each condition encountered in work.
- B. **Shop Drawings:** Detailed plans, sections, and large-scale details of products.
1. Base flashings and membrane terminations.
 2. Tapered insulation, including slopes.
 3. Orientation of steel roof deck and orientation of membrane roofing and fastening spacings and patterns for mechanically fastened membrane roofing.
 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. **Samples for Verification:**
1. Sheet roofing, of color specified, including T-shaped side and end lap seam.
 2. Substrate board.
- D. **Maintenance Data:** For inclusion maintenance manual required by appropriate Division 01 Section.
1. Include manufacturer's instructions for maintenance of installed work
 2. Include methods and frequency recommended for maintaining optimum condition under anticipated use.
 3. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

4. Include name, address, and telephone number of manufacturer's nearest authorized service representative.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Experience: Company with **not less than 5 years' experience** in performing specified work similar in design, products, and extent to scope of this Project; with a record of successful in-service performance; and with sufficient production capability, facilities, and trained and skilled personnel.
2. Supervision: Maintain a competent supervisor who is at Project during times specified work is in progress, and, who is experienced in installing work similar in design, products, and extent to scope of this Project.
3. Manufacturer Qualification: Certified, licensed, approved, or acceptable to manufacturer to install specified work.

B. Pre-Installation Conference: Before beginning work of this Section, conduct conference at site to comply with requirements of appropriate Division 01 Sections.

1. Required Attendees:
 - a. Owner.
 - b. Architect.
 - c. Contractor, including supervisor.
 - d. Roof decking installer, including supervisor.
 - e. Installers of adjacent work, including supervisors.
 - f. Testing agency personnel, including supervisors.
 - g. Manufacturer's technical representative.
2. Minimum Agenda:
 - a. Review Contract Document requirements.
 - b. Review approved submittals.
 - c. Review installation procedures, including, but not limited to, following:
 - 1) Manufacturer's methods and procedures.
 - 2) Structural loading limitations of roof deck during and after roofing
 - 3) Preparation of substrates to receive membrane roofing.
 - 4) Substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5) Placement and attachment of roof membrane.
 - 6) Base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - 7) Roof accessories and roof-mounted equipment.
 - 8) Repair procedures after roofing installation.
 - d. Review forecasted weather conditions and procedures for coping with unfavorable conditions.
 - e. Tour representative areas of required Work, discuss and evaluate for compliance with Contract Documents, including substrate conditions, surface preparations, sequence of installation and other preparatory Work performed by other installers.
3. Reports: Record discussions, including decisions and agreements reached, and prepare report.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
- C. Handle and store roofing materials and place equipment in a manner to avoid permanent

deflection of deck.

1.7 PROJECT CONDITIONS

- A. **Weather Limitations:** Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.8 WARRANTY

- A. **Manufacturer's Extended Warranty:** Furnish executed copy of roofing manufacturer's "No Dollar Limit" warranty agreement signed by authorized representative of thermoplastic polyolefin single-ply membrane roofing manufacturer against defective material and faulty workmanship for **20 years from date of substantial completion.**
- B. **Installer's Extended Warranty:** Furnish executed copy of roofing installer's "edge-to-edge" warranty agreement signed by authorized representative of roofing installer against faulty workmanship for **two years from date of substantial completion.**

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as judged by Architect.
 - 1. **Manufacturer:** GAF.
 - 2. **Specification:** TFANI60.
 - 3. **Polyisocyanurate Board Insulation:** EnergyGuard Polyiso Insulation.
 - 4. **Insulation Adhesive:** OlyBond 500.
 - 5. **Membrane:** EverGuard TPO.
 - 6. **Membrane Adhesive:** 1121 Bonding Adhesive.
- B. **Other Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Carlisle SynTec Incorporated.
 - 2. Firestone Building Products Company.
 - 3. GAF Materials Corporation.
 - 4. Johns Manville International, Inc.

2.2 MATERIALS, GENERAL

- A. **Source Limitations:** Obtain components from same manufacturer as membrane roofing or from source approved by membrane roofing manufacturer.
- B. **Material Compatibility:** Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

2.3 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE

- A. **Fabric-Reinforced Thermoplastic Polyolefin Sheet:** ASTM D 6878, uniform, flexible sheet formed from a thermoplastic polyolefin, internally fabric or scrim reinforced, and as follows:
 - 1. Thickness: 60 mils, nominal.
 - 2. Exposed Face Color: White.
 - 3. Physical Properties:
 - a. Breaking Strength: 225 lbf; ASTM D 751, grab method.
 - b. Elongation at Break: 15 percent; ASTM D 751.
 - c. Tearing Strength: 55 lbf minimum; ASTM D 751, Procedure B.
 - d. Brittleness Point: Minus 22 deg F.

- e. **Ozone Resistance:** No cracks after sample, wrapped around a 3-inch- diameter mandrel, is exposed for 166 hours to a temperature of 104 deg F and an ozone level of 100 pphm; ASTM D 1149.
- f. **Resistance to Heat Aging:** 90 percent minimum retention of breaking strength, elongation at break, and tearing strength after 166 hours at 240 deg F; ASTM D 573.
- g. **Water Absorption:** Less than 4 percent mass change after 166 hours' immersion at 158 deg F; ASTM D 471.
- h. **Linear Dimension Change:** Plus or minus 2 percent; ASTM D 1204.

2.4 AUXILIARY MATERIALS

- A. **General:** Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
- B. **Sheet Flashing:** Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils thick, minimum, of same color as sheet membrane.
- C. **Bonding Adhesive:** Manufacturer's standard solvent-based bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings.
- D. **Metal Termination Bars:** Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- E. **Fasteners:** Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening substrate board to roof deck, membrane to substrate, and acceptable to membrane roofing system manufacturer.
- F. **Miscellaneous Accessories:** Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, slip sheet, and other accessories.

2.5 INSULATION

- A. **Polyisocyanurate Board Insulation:** ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces, maximum 2 inch thickness.
- B. **Cover Board:** ASTM C 1289, high density polyisocyanurate board with felt or glass-fiber mat facer on both major surfaces, 1/2 inch thick.
- C. **Tapered Insulation:** Factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

2.6 INSULATION ACCESSORIES

- A. **Fasteners:** Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to steel deck, and acceptable to roofing system manufacturer.
- B. **Insulation Adhesive:** Insulation manufacturer's recommended cold-applied adhesive formulated to attach roof insulation to concrete deck or to another insulation layer.

2.7 WALKWAYS

- A. **Additional layer of 60 mil roof membrane material.**
 - 1. Color: Gray or contrasting color to primary roofing material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Acceptance of Surfaces and Conditions:**
 - 1. Examine substrates to receive thermoplastic polyolefin roofing and associated work will be applied for compliance with requirements and other conditions affecting performance.
 - 2. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
 - 3. Starting work within a particular area will be construed as acceptance of surface conditions.
- B. **Verifications:** Verify following for compliance with requirements and other conditions affecting performance of roofing system:

1. Roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
2. Wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
- D. **Adhered Insulation at Concrete Deck:** Adhere each layer of insulation and cover board using insulation adhesive.
- E. **Mechanically Fastened at Steel Deck:** Loose lay each layer of insulation and cover board and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

3.4 ADHERED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
 1. Install sheet according to ASTM D 5036.
 2. Provide additional layer of "sacrificial" membrane at all attachment points for lightning protection or other necessary rooftop systems. Coordinate location and attachment with system provider and include final installation under required warranty.
- B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply water-based bonding adhesive to substrate at rate required by manufacturer and immediately install roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.
- E. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.
 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
 3. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.
- F. Quality: Install roof so there is no ponding of water in any area and roof membrane is smooth with no bubbles or creases.

3.5 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with sheet flashing.
- D. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.

3.6 WALKWAY INSTALLATION

- A. Walkways: Install additional layer of roofing membrane in locations indicated. Adhere walkway according to roofing system manufacturer's written instructions. Coordinate final location of walkways with actual installation of equipment. Verify location with Architect prior to installation.

3.7 FIELD QUALITY CONTROL

- A. **Final Roof Inspection:** Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
- B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

3.8 PROTECTION

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

END OF SECTION

SECTION 076200

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES:

- A. **Counter flashing.**

1.3 PERFORMANCE REQUIREMENTS

- A. General: Manufacture and install manufactured roof specialties to resist thermally induced movement and exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. **Thermal Movements:** Provide manufactured roof specialties that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. **Temperature Change (Range):** 120 deg F(67 deg C), ambient; 180 deg F(100 deg C), material surfaces.
- C. **Water Infiltration:** Provide manufactured roof specialties that **do not allow water infiltration** to building interior.

1.4 PRE-INSTALLATION CONFERENCE

- A. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of fabrication, expansion, waterproofing, and dissimilar metals interface.

1.5 SUBMITTALS

- A. **Product Data:** Indicating performance and physical characteristics of products proposed for use.
- B. **Color Charts:** Manufacturer's pre-finished metal color charts. Include all colors and product lines, showing actual physical coating.
- C. **Manufacturer's Instructions:** Printed manufacturer's installation instructions.
- D. **Warranty:** Two copies of water-tightness warranty, and finish coating warranty on pre-finished products for pre-finished products.

1.6 QUALITY ASSURANCE

- A. **Installer Qualifications:** Company specializing in sheet metal flashing work with **10 years minimum experience in similar sized installations.**
- B. **Quality Standard:** Comply with SMACNA Architectural Sheet Metal Manual.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, handle, and protect products under provisions of Sections 016000.

- B. Stack pre-formed material to prevent twisting, bending, and abrasions, and to provide ventilation.
- C. Prevent contact with materials which may cause discoloration or staining.
- D. Ship pre-coated products with strippable covering.

1.8 WARRANTY

- A. Provide warranties under provisions of Section 017800.
- B. **Provide installer and general contractor 10 year water tightness guarantee** beginning at substantial completion including repair or replacement of defective materials and workmanship.

PART 2 - PRODUCTS

2.1 SHEET MATERIALS

- A. **Aluminum (all exposed and unexposed flashings except at concealed gutter):** ASTM B209, 5005 alloy, temper as required for intended application (15 KSI minimum), **thickness as recommended in Specifications for Aluminum Sheet Metal Work in Building Construction** for intended purposes. Manufacturer at Contractor's option.
 - 1. **Exposed Coil-Coated Finish:**
 - a. **Two-Coat Fluoropolymer:** AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. **Color:** As indicated in Section 008900 - Finish Selection Summary.
- B. **Copper Sheet (at concealed gutters):** ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.
 - 2. **Exposed Finish:** Mill.
 - 3. **Thickness:** 32 oz./sq. ft.
- C. **Sealant:** One part, non-sag polyurethane.

2.2 ACCESSORIES

- A. **Fasteners for Aluminum:**
 - 1. Nails: AISI Series 300 for stainless and galvanized steel; aluminum for aluminum sheets. Use annular ring shank type, No. 12 gage or larger to suit application, of sufficient length to penetrate backing material at least 7/8 inch.
 - 2. Screws and Bolts: AISI Series 300 for stainless and galvanized steel; and aluminum for aluminum sheets; of sufficient size and length to sustain imposed stresses.
- B. **Fasteners for Copper:** Copper, hardware bronze or passivated Series 300 stainless steel.
- C. **Protective Back Paint:** Zinc chromate alkyd.
- D. **Sealants:** One component polyurethane, non-sagging, sealant as specified in Section 079200.

2.3 FABRICATION

- A. Form sections true to shape, accurate in size, square, free from distortion and defects, to profiles indicated **in accordance with current edition of SMACNA Architectural Sheet Metal Manual.**
- B. Form pieces in longest practical lengths.
- C. Hem exposed flashings on underside 1/2 inch; miter and seam corners.
- D. Form materials which are typically concealed from view by the public with lap seams.
- E. **Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.**
- F. Fabricate corners from one place with minimum 18 inch long legs; solder for rigidity or seal with sealant if approved by Architect.

- G. Fabricate vertical faces with bottom edge formed outward 1/8 inch and hemmed to form drip.
- H. Fabricate flashings to allow toe to extend per Drawings or a minimum of 2 inches over wall surfaces.
- I. Fabricate as much as possible in shop with machinery to eliminate as much hand tooling on the job as possible. Shop fabricate to allow for adjustments in the field for proper anchoring and joining.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready to receive work of this section. Notify General Contractor of any existing conditions which will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.
- B. Verify roof openings, pipes, sleeves, and vents through roof are solidly set, and nailing strips located.
- C. Verify membrane termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

- A. Field measure site conditions prior to fabricating work.

3.3 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturer's printed instruction and recommendations.
- B. Conform to drawing details included in manuals published by SMACNA, AA, and NRCA.
- C. **Secure flashings in place using concealed fasteners.** Use exposed fasteners only in locations approved by Architect and never in plain view.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- E. Seal metal joints watertight at gutters, scuppers, and downspouts, leaders and conductor heads.
- F. **Provide electrolytic separation between dissimilar metals with protective back paint.**
- G. **Seal joints** as shown and as required for watertight construction.
 - 1. **Solder all joints at copper installations.**
 - 2. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
- H. **Install expansion joints at frequency as recommended in SMACNA Architectural Sheet Metal Manual. Do not fasten seams such that movement is restricted.** Coordinate expansion joint locations with joints in adjacent materials. Install building expansion joints where indicated.

3.4 QUALITY CONTROL

- A. Install surfaces flat such that from normal viewing distances, no waviness or oil canning is visible.

3.5 CLEANING

- A. Perform final cleaning under provisions of Section 017800.

3.6 PROTECTION

- A. Protect finished installation under provisions of Section 015000.

END OF SECTION

SECTION 077100

MANUFACTURED ROOF SPECIALTIES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 SUMMARY
 - A. **Section Includes:**
 - 1. **Roof edge drainage systems.**
 - 2. **Prefinished metal Copings.**
 - 3. **Collection boxes.**
- 1.3 **PERFORMANCE REQUIREMENTS**
 - A. General: Manufacture and install manufactured roof specialties to resist thermally induced movement and exposure to weather without failing, rattling, leaking, and fastener disengagement.
 - B. **SPRI Wind Design Standard:** Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
 - 1. Design Pressure: As indicated - refer structural.
 - C. **Thermal Movements:** Provide manufactured roof specialties that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
 - D. **Water Infiltration:** Provide manufactured roof specialties that **do not allow water infiltration** to building interior.
- 1.4 SUBMITTALS
 - A. General: Submit in accordance with Section 013300.
 - B. **Product Data:** For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - C. **Shop Drawings:** Show layouts of manufactured roof specialties, including plans and elevations. Identify factory- vs. field-assembled work. Include the following:
 - 1. Details for fastening, joining, supporting, and anchoring manufactured roof specialties including fasteners, clips, cleats, and attachments to adjoining work.
 - 2. Details for expansion and contraction.
 - D. **Fabrication Samples:** For copings made from 12 inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.
 - E. **Product Test Reports:** Based on evaluation of comprehensive tests performed by a qualified testing agency, verifying compliance of copings with performance requirements.
- 1.5 COORDINATION
 - A. Coordinate installation of manufactured roof specialties with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

- 2.1 **EXPOSED METALS**
 - A. **Aluminum Sheet:** ASTM B 209, alloy as standard with manufacturer for finish required, with

temper to suit forming operations and performance required.

1. **Surface:** Smooth, flat finish.
2. **Exposed Coil-Coated Finishes:** Prepainted by the coil-coating process to comply with ASTM A 755. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. **Two-Coat Fluoropolymer:** AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 - 1) **Color:** Refer to Section 008900 – Finish Selection Summary.

2.2 CONCEALED METALS

- A. **Aluminum Sheet:** ASTM B 209, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

2.3 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, separators, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. **Fasteners:** Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
- C. **Sealing Tape:** Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
- D. **Elastomeric Sealant:** ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. **Bituminous Coating:** Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.4 ROOF-EDGE DRAINAGE SYSTEMS

- A. **Gutters:** Manufactured in uniform section lengths not exceeding 12 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
 1. Material: 22 ga. copper.
 2. **Gutter Profile:** Style as indicated on Drawings, and according to SMACNA's "Architectural Sheet Metal Manual."
 3. **Corners:** Welded.
 4. **Gutter Supports:** Manufacturer's standard supports as selected by Architect with finish matching the gutters.
 5. **Gutter Accessories:** Continuous hinged leaf guard of solid metal designed to shed leaves.
- B. **Downspouts:** 6" X 6" 24 ga. copper rectangular, or larger as required, prefinished complete with mitered elbows, manufactured from the exposed coil-coated metal. Furnish with metal hangers, from same material as downspouts and anchors.
 1. Provide all parts necessary to provide sealed connections to underground storm drainage system.
- C. **Collection Boxes:** Manufactured collection boxes, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, and built-in overflow; 24 ga copper.
- D. **Concrete Splash Pans:** Precast concrete with groove to direct water flow.

2.5 COPINGS

- A. **Copings:** Manufactured standard system consisting of formed-metal coping cap in section

lengths not exceeding 12 feet, concealed anchorage, concealed splice plates with same finish as coping caps, mitered corner units, and end cap units.

1. **Available Products:**

a. **Pac-Tite Tapered Coping** by Pac-Clad/Peterson Aluminum **with 20 year warranty; FM 1-90 certification.** Meeting ANSI/SPRI ES-1 standard test.

2. **Material:** Formed aluminum, thickness as required to meet performance requirements.

a. **Finish:** 2-coat fluoropolymer, refer to Section 008900 for final color selection.

3. **Corners: Continuously welded.**

4. **Snap-on Coping Anchor Plates:** Concealed, galvanized steel sheet, 12 inches wide, 0.028 inch thick, with integral cleats and stainless steel fasteners.

B. **Self-Adhering, High-Temperature Sheet:** Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.

2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.

3. **Basis of Design:** Henry Company; Blueskin PE200 HT.

2.6 ROOF EDGES AND GRAVEL STOPS

A. Roof Edges and Gravel Stops: Manufactured standard system consisting of formed-metal profiles indicated in section lengths not exceeding 12 feet, concealed anchorage, concealed splice plates with same finish as roof edges and gravel stops, and mitered corner units.

1. **Material:** Formed aluminum, thickness as required to meet performance requirements.

a. **Finish:** 2-coat fluoropolymer, refer to Section 008900 for final color selection.

2. **At Clay Tile Roofing:** 22 ga. copper.

3. At dissimilar materials, provide bituminous paint.

2.7 FINISHES

A. Refer to Drawings and Section 008900 - Finish Selection Summary.

B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

C. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. **Examine substrates, areas, and conditions**, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.

1. Examine walls, roof edges, and parapets for suitable conditions for manufactured roof specialties.

2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install manufactured roof specialties according to manufacturer's written instructions. Anchor manufactured roof specialties securely in place and capable of resisting forces specified in performance requirements. Use fasteners, separators, sealants, and other miscellaneous items as required to complete manufactured roof specialty systems.

1. Install manufactured roof specialties with provisions for thermal and structural movement.
 2. Torch cutting of manufactured roof specialties is not permitted.
- B. **Metal Protection:** Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. **Underlayment:** Where installing exposed-to-view components of manufactured roof specialties, install a layer of thru-wall flashing underlayment and adhere to substrate.
- C. Install manufactured roof specialties level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil-canning, buckling, or tool marks.
- D. Install manufactured roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
- E. **Expansion Provisions:** Provide for thermal expansion of exposed manufactured roof specialties. Space movement joints at a **maximum of 12 feet o.c.** with no unplanned joints within 18 inches of corners or intersections.
- F. **Fasteners:** Use fasteners of type and size recommended by manufacturer but of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- G. Seal joints with elastomeric sealant as required by manufacturer of roofing specialties.
- 3.3 **ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION**
- A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. **Gutters:** Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion joint caps.
 2. Install continuous leaf guards on gutters with non-corrosive fasteners, removable for cleaning gutters.
- C. **Downspouts:** Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.
1. Provide elbows at base of downspout to direct water away from building.
 2. **Hold downspouts tight against building envelope. Cut cast stone trim and other appurtenances to allow gutter to remain vertical without offsets.**
- D. **Collection Boxes:** Anchor securely to wall with elevation of conductor top edge 1 inch below scupper discharge.
- E. **Splash Pans:** Install where downspouts discharge at grade.
- 3.4 **COPING INSTALLATION**
- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. **Anchor copings to resist uplift and outward forces according to performance requirements.**
1. Interlock front and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's recommended spacing.
- 3.5 **CLEANING AND PROTECTION**
- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Remove temporary protective coverings and strippable films as manufactured roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

- C. Replace manufactured roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 077200
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes:**
 - 1. **Equipment supports (roof curbs).**
 - 2. **Roof hatches.**
 - 3. **Pipe supports.**

1.3 PERFORMANCE REQUIREMENTS

- A. **General Performance:** Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. **Design Wind Loads:** As indicated on structural drawings or as otherwise determined using design wind loads applicable to Project from basic wind speed indicated in miles per hour, according to ASCE 7, Section 6.5, "Method 2-Analytical Procedure."

1.4 SUBMITTALS

- A. **Product Data:** For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. **Shop Drawings:** For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. **Samples:** For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.
- D. **Operation and Maintenance Data:** For roof accessories to include in operation and maintenance manuals. Provide at project close-out.
- E. **Warranty:** Sample of special warranty.

1.5 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and non-corrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.6 WARRANTY

- A. **Special Warranty on Painted Finishes:** Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. **Fluoropolymer Finish:** Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. **Finish Warranty Period:** **20 years** from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. **Aluminum-Zinc Alloy-Coated Steel Sheet:** ASTM A 792/A 792M, AZ50 coated.
 - 1. **Exposed Coil-Coated Finish:** Prepainted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. **Two-Coat Fluoropolymer Finish:** AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 - 2. **Concealed Finish:** Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- B. **Aluminum Extrusions and Tubes:** ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.
- C. **Stainless-Steel Sheet and Shapes:** ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. **Steel Shapes:** ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- E. **Galvanized-Steel Tube:** ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
- F. **Steel Pipe:** ASTM A 53/A 53M, galvanized.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. **Glass-Fiber Board Insulation:** ASTM C 726, thickness as indicated.
- C. **Wood Nailers:** Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick. Provide fire retardant treated where required by code.
- D. **Underlayment:**
 - 1. **Basis of Design:** Henry Bluskin PE200HT for warranty reasons with air barrier.
- E. **Fasteners:** Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 - 1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
 - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - 3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 - 4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- F. **Elastomeric Sealant:** ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

2.3 EQUIPMENT SUPPORTS (ROOF CURBS)

- A. **Equipment Supports:** Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Curbs Plus, Inc.

- b. Custom Solution Roof and Metal Products.
 - c. Pate Company (The).
 - d. Thybar Corporation.
 - B. **Size:** Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
 - C. **Material:** 0.050 inch thick aluminum.
 - 1. **Finish:** Two-coat fluoropolymer.
 - 2. **Color:** As selected by Architect from manufacturer's full range.
 - D. **Construction:**
 - 1. **Insulation:** Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
 - 2. **Liner:** Same material as equipment support, of manufacturer's standard thickness and finish.
 - 3. **Factory-installed continuous wood nailers** 3-1/2 inches wide at tops of equipment supports.
 - 4. **Metal Counterflashing:** Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
 - 5. Fabricate equipment supports to minimum height of 12 inches unless otherwise indicated.
 - 6. **Security Grille:** Provide where indicated.
- 2.4 **ROOF HATCH (NOT USED)**
- A. **Roof Hatches:** Aluminum roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis.
 - b. Bilco Company (The).
 - c. J. L. Industries, Inc.
 - d. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - e. Nystrom.
 - f. O'Keeffe's Inc.
 - B. **Type and Size:** Single-leaf, 36" X 72"; one total count; verify size with Drawings and Architect prior to ordering.
 - C. **Loads:** Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.
 - D. **Hatch Material:** 0.090 inch thick aluminum.
 - 1. **Finish:** Mill finish.
 - E. **Construction:**
 - 1. **Insulation:** Glass-fiber board.
 - 2. **Curb Liner:** Manufacturer's standard, of same material and finish as metal curb.
 - 3. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 - 4. Fabricate curbs to **minimum height of 12 inches above roof surface** unless otherwise indicated.
 - F. **Hardware:** Stainless steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
 - 1. Provide two-point latch on lids larger than 84 inches.
 - G. **Guardrail System:** Roof hatch manufacturer's standard guardrail device for attachment to hatch. Required for all roof hatches located within 10 feet of roof edge.
 - 1. Height: 42 inches above finished roof deck
 - H. **Ladder-Assist Post:** Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
 - 1. **Operation:** Post locks in place on full extension; release mechanism returns post to closed position.

2. **Height:** 42 inches above finished roof deck.
3. **Material:** Aluminum.
4. **Post:** 1-5/8-inch- diameter pipe.
5. **Finish:** Mill.

2.5 **PIPE SUPPORTS**

A. **Pipe Supports:**

1. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Portable Pipe Hangers Inc.
2. **Pipe Support Height:** As indicated on Drawings.
3. **Roller Assembly:** With stainless-steel roller and high density polypropylene base plate, sized for supported pipes.

2.6 **GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 **EXAMINATION**

- A. **Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.**
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **INSTALLATION**

- A. General: Install roof accessories according to manufacturer's written instructions.
 1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. **Metal Protection:** Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 1. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slipsheet, or install a course of polyethylene sheet.
- C. **Equipment Support (Roof Curb) Installation:** Install equipment supports so top surfaces are level with each other.
- D. **Roof-Hatch Installation:**
 1. Install roof hatch so top surface of hatch curb is level.
 2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 3. Attach ladder-assist post according to manufacturer's written instructions.
- E. **Pipe Support Installation:** Install pipe supports so top surfaces are in contact with and provide

- equally distributed support along length of supported item.
- F. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Division 09 painting Sections.
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.4 SCHEDULE

- A. **Roof Hatch (Not Used):** Provide at locations indicated on the Drawings, but not less than at location to be determined by Architect.
- B. **Pipe Supports:** Provide at 3'-0" o.c. under all exposed roof piping and as otherwise indicated on the Drawings or indicated on MEP Drawings.
- C. **Equipment Supports (Roof Curbs):** Provide at all mechanical equipment penetrations on roof, as otherwise indicated on the Drawings, and as indicated on the MEP Drawings.

END OF SECTION

SECTION 078100

APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes:** Spray Applied Fire Resistive Materials (SFRMs) applied to surfaces that are concealed from view behind other construction when the Work is completed.

1.3 SUBMITTALS

- A. **Product Data:** For each type of product indicated.
- B. **Shop Drawings:** Show extent of sprayed fire-resistive material for each construction and fire-resistance rating, applicable fire-resistive design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction, and minimum thicknesses.
- C. **Field quality-control** test and special inspection reports.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified installer approved by SFRM manufacturer to install manufacturer's products. A manufacturer's willingness to sell its SFRM to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
- B. **SFRM Testing:** By a qualified testing and inspecting agency engaged by Contractor or manufacturer to test for compliance with specified requirements for performance and test methods.
 - 1. SFRMs are randomly selected for testing from bags bearing the applicable classification marking of UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 2. Testing is performed on specimens of SFRMs that comply with laboratory testing requirements specified in Part 2 and are otherwise identical to installed fire-resistive materials, including application of accelerant, sealers, topcoats, tamping, troweling, rolling, and water overspray, if any of these are used in final application.
 - 3. Testing is performed on specimens whose application the independent testing and inspecting agency witnessed during preparation and conditioning. Include in test reports a full description of preparation and conditioning of laboratory test specimens.
- C. **Compatibility and Adhesion Testing:** Engage a qualified testing and inspecting agency to test for compliance with requirements for specified performance and test methods.
 - 1. Test for bond per ASTM E 736 and requirements in UL's "Fire Resistance Directory" for coating materials. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 - 2. Verify that manufacturer, through its own laboratory testing or field experience, has not found primers or coatings to be incompatible with SFRM.
- D. **Fire-Test-Response Characteristics:** Where indicated, provide products identical to those tested for fire resistance per ASTM E 119 by a testing agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 2. Identify products with appropriate markings of applicable testing and inspecting agency.
- E. **Provide products containing no detectable asbestos as determined according to the method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."**

1.5 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not apply SFRM when ambient or substrate temperature is 40 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. **Ventilation:** Ventilate building spaces during and after application of SFRM. Use natural means or, if they are inadequate, forced-air circulation until fire-resistive material dries thoroughly.
- C. Sequence and coordinate application of SFRM with other related work specified in other Sections to comply with the following requirements:
 - 1. Provide temporary enclosure as required to confine spraying operations and protect the environment.
 - 2. Provide temporary enclosures for applications to prevent deterioration of fire-resistive material due to exposure to weather and to unfavorable ambient conditions for humidity, temperature, and ventilation.
 - 3. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
 - 4. Do not apply fire-resistive material to metal roof deck substrates until concrete topping, if any, has been completed. For metal roof decks without concrete topping, do not apply fire-resistive material to metal roof deck substrates until roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material.
 - 5. Do not apply fire-resistive material to metal floor deck substrates until concrete topping has been completed.
 - 6. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
 - 7. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
 - 8. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, and tested and corrections have been made to defective applications.

1.6 WARRANTY

- A. **Special Warranty:** Manufacturer's standard form, signed by Contractor and by Installer, in which manufacturer agrees to repair or replace SFRMs that fail in materials or workmanship within specified warranty period.
 - 1. **Failures** include, but are not limited to, the following:
 - a. Cracking, flaking, spalling, or eroding in excess of specified requirements; peeling; or delaminating of SFRM from substrates.
 - b. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.
 - 2. **Warranty Period:** **Five years** from date of substantial completion.

PART 2 - PRODUCTS

2.1 CONCEALED SFRM

- A. **Acceptable Products:**
 - 1. GCP Applied Technologies; Monokote MK-6 Series.
 - 2. Carbolite Company; RPM International; AD Southwest Fireproofing Type 5GP.
 - 3. Isolatek International, Inc; Cafco 300.
- B. **Material Composition:** Manufacturer's standard product, as follows:
 - 1. **Concealed Sprayed-Fiber Fire-Resistive Material:** Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.

- C. **Physical Properties:** Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
1. **Dry Density: 15 lb/cu. ft. for average and individual densities**, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
 2. **Thickness:** Minimum average thickness required for fire-resistance design indicated according to the following criteria, but not less than 0.375 inch, per ASTM E 605:
 - a. Where the referenced fire-resistance design lists a thickness of 1 inch or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch.
 - b. Where the referenced fire-resistance design lists a thickness of less than 1 inch but more than 0.375 inch, the minimum allowable individual thickness of SFRM is the greater of 0.375 inch or 75 percent of the design thickness.
 - c. No reduction in average thickness is permitted for those fire-resistance designs whose fire-resistance ratings were established at densities of less than 15 lb/cu. ft.
 3. **Bond Strength:** 150 lbf/sq. ft. minimum per ASTM E 736 based on laboratory testing of 0.75-inch minimum thickness of SFRM.
 4. **Compressive Strength:** 5.21 lbf/sq. in. minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch and minimum dry density shall be as specified but not less than 15 lb/cu. ft.
 5. **Corrosion Resistance:** No evidence of corrosion per ASTM E 937.
 6. **Deflection:** No cracking, spalling, or delamination per ASTM E 759.
 7. **Effect of Impact on Bonding:** No cracking, spalling, or delamination per ASTM E 760.
 8. **Air Erosion:** Maximum weight loss of 0.025 g/sq. ft. in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch, maximum dry density is 15 lb/cu. ft., test specimens are not prepurged by mechanically induced air velocities, and tests are terminated after 24 hours.
 9. **Fire-Test-Response Characteristics:** Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - a. Flame-Spread Index: 0.
 - b. Smoke-Developed Index: 0.
 10. **Fungal Resistance:** No observed growth on specimens per ASTM G 21.

2.2 AUXILIARY FIRE-RESISTIVE MATERIALS

- A. General: Provide auxiliary fire-resistive materials that are compatible with SFRM and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. **Substrate Primers:** For use on each substrate and with each sprayed fire-resistive product, provide primer that complies with one or more of the following requirements:
1. Primer's bond strength complies with requirements specified in UL's "Fire Resistance Directory" for coating materials based on a series of bond tests per ASTM E 736.
 2. Primer is identical to those used in assemblies tested for fire-test-response characteristics of SFRM per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of work. A substrate is in satisfactory condition if it complies with the following:
1. Substrates comply with requirements in the Section where the substrate and related materials and construction are specified.

2. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, incompatible paints, incompatible encapsulants, or other foreign substances capable of impairing bond of fire-resistive materials with substrates under conditions of normal use or fire exposure.
3. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
4. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.
5. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Verify that concrete work on steel deck has been completed.
- C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work are completed.
- D. **Conduct tests according to fire-resistive material manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.**
- E. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application.
- F. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, and incompatible primers, paints, and encapsulants.
- G. **Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.**
- H. Coat substrates with bonding adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by SFRM manufacturer for material and application indicated.
- I. **Extend fire-resistive material in full thickness over entire area of each substrate to be protected.** Unless otherwise recommended in writing by SFRM manufacturer, install body of fire-resistive covering in a single course.
- J. Spray apply fire-resistive materials to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by SFRM manufacturer.
- K. Where sealers are used, apply products that are tinted to differentiate them from SFRM over which they are applied.
- L. Apply concealed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if specified in Part 2 "Concealed SFRM" Article.
- M. Cure concealed SFRM according to product manufacturer's written recommendations.
- N. Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- O. Repair or replace work that has not successfully protected steel.

3.2 FIELD QUALITY CONTROL

- A. **Special Inspections:** Engage a qualified special inspector to perform the following special inspections and prepare reports:
 1. SFRM.
 2. Intumescent Coating
- B. **Testing Agency:** Engage a qualified testing agency to perform tests and inspections and prepare test reports.
 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- C. **Tests and Inspections:** Testing and inspecting of completed applications of SFRM shall take place in successive stages, in areas of extent and using methods as follows. **Do not proceed with application of SFRM for the next area until test results for previously completed**

applications of SFRM show compliance with requirements. Tested values must equal or exceed values indicated and required for approved fire-resistance design.

1. **Thickness for Floor, Roof, and Wall Assemblies:** For each 1000-sq. ft. area, or partial area, on each floor, from the average of 4 measurements from a 144-sq. in. sample area, with sample width of not less than 6 inches per ASTM E 605.
 2. **Thickness for Structural Frame Members:** From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.
 3. **Density for Floors, Roofs, Walls, and Structural Frame Members:** At frequency and from sample size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
 4. **Bond Strength for Floors, Roofs, Walls, and Structural Framing Members:** For each 10,000-sq. ft. area, or partial area, on each floor, cohesion and adhesion from one sample of size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 736.
 - a. Field test SFRM that is applied to flanges of wide-flange, structural-steel members on surfaces matching those that will exist for remainder of steel receiving fire-resistive material.
 - b. If surfaces of structural steel receiving SFRM are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria, but not less than 150 lbf/sq. ft. minimum per ASTM E 736.
 5. If testing finds applications of SFRM are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.
- D. Remove and replace applications of SFRM that do not pass tests and inspections for cohesion and adhesion, for density, or for both and retest as specified above.
- E. Apply additional SFRM, per manufacturer's written instructions, where test results indicate that thickness does not comply with specified requirements, and retest as specified above.

3.3 SCHEDULE

- A. Provide thickness as required to achieve 1 hour fire rating on all steel structure not exposed to view. Confirm final locations with Architect.

END OF SECTION

SECTION 078400

FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Installation of firestopping materials at openings, penetrations, and voids in, and at periphery of fire-rated construction**

1.3 DEFINITIONS

- A. **Firestopping:** A material, or combination of materials, to retain the integrity of time-rated construction by maintaining an effective barrier against the spread of flame, smoke, and gasses **used in specific locations as follows:**
 - 1. Ducts, cables, conduits, and piping penetrations through fire rated floor construction and through fire rated partitions.
 - 2. Openings between and at edges of floor slabs (i.e., expansion joints)
 - 3. Penetrations of vertical shafts
 - 4. Other locations where specifically shown on the drawings, where specified or required by codes.

1.4 QUALITY ASSURANCE

- A. Submit the following in accordance with Section 013300.
 - 1. **Product data, letter of certification, or certified laboratory test report** that the material or combination of materials meet the requirements specified in ASTM E814 and UL 1479 and are so classified in UL's Building Materials Directory.
- B. Materials shall meet and be acceptable for applicable building code.
- C. Materials shall meet the requirements of NFPA 101 - LIFE Safety Code and NFPA 70 - National Electrical Code.

1.5 SUBMITTALS

- A. Submit shop drawings, product data, samples, certificates, and manufacturer's installation instructions under provisions of Section 013300.
- B. **Submit manufacturer's product data** for all materials and prefabricated devices, providing descriptions sufficient for identification at the job site. Include manufacturer's instructions for installation.
- C. **Submit shop drawings** showing proposed material, reinforcement, anchorage, fastenings, and method of installation. Construction details shall accurately reflect actual job conditions.
- D. **Submit actual samples** of each product proposed for use, in its installed state.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 016000.
- B. Deliver in original unopened containers or packages bearing manufacturers' name, brand designation, and product description.
- C. Store materials under cover and protected from damage under provisions of Section 016000.
- D. Do not use damaged materials.

1.7 SEQUENCING/SCHEDULING

- A. Coordinate the work of this Section with work performed under other Sections of the Project Manual.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. To the extent products of the following manufacturers meet or exceed specified requirements, the following are acceptable.
 - 1. The Rectorseal Corp., Houston, TX
 - 2. 3M Fire Protection Products, St. Paul, MN
 - 3. Specified Technologies Inc., Sommerville, NJ
 - 4. Hilti.
 - 5. Accepted Substitute in accordance with Section 016000.

2.2 FIRESTOPPING MATERIALS

- A. **Through Penetration Firestopping System.** Comply with UL classification XHEZ.
 - 1. **Acceptable Manufacturers:**
 - a. FireMaster, Thermal Ceramics, Augusta, GA
 - b. The Rectorseal Corp., Houston, TX
 - c. 3M Fire Protection Products, St. Paul, MN
 - d. Tremco, Beachwood, OH
 - e. United States Gypsum Company, Chicago, IL
 - f. Accepted Substitute in accordance with Section 016000.
- B. **Fire Retardant Sealants:** Single component, asbestos free, neutral cure.
 - 1. **Acceptable Manufacturers and Products:**
 - a. Specified Technologies Inc: LC1 Firestop Sealant
 - b. Rectorseal:
 - 1) Biotherm 100 (non-sag); 200 (self-leveling)
 - 2) Metacaulk 835, 880, 910, 950
 - c. 3M Products: Fire Barrier CP-25WB; CP-25N/S (no-sag); CP-25S/L (self-leveling), Fire Dam 150.
 - d. Tremco: Fyre-Shield.
 - e. United States Gypsum Company: Thermafiber Smoke Seal.
- C. **Fire-Resistive Elastomeric Joint Sealants:** Single component, asbestos free, neutral cure.
 - 1. **Movement Capability: 40 percent, ASTM C719.**
 - 2. **Acceptable Manufacturers and Products:**
 - a. Specified Technologies Inc: LC1 Firestop Joint Sealant
 - b. 3M Products: Fire Barrier 2000/2003 Silicone Sealant.
 - c. Tremco: Fyre-Sil, Fyre-Sil S/L
 - d. Rectorseal: Metacalk 880
- D. **Fire Retardant Putty:** Single component, asbestos free, dielectric, non-hardening, intumescent putty
 - 1. **Acceptable Manufacturers and Products:**
 - a. Specified Technologies Inc: SpecSeal Firestop Putty
 - b. Tremco: Tremstop FP
 - c. 3M: Fire Barrier Moldable Putty
- E. **Fire Retardant Job-Mixed Vinyl Compound:** Dry gypsum/vinyl compound, non-asbestos, site mixed with water
 - 1. **Acceptable Manufacturers and Products:**
 - a. United States Gypsum Company: Firecode Compound.
 - b. National Gypsum Company: Sta-smooth FS 90 Fire-Shield Compound
- F. **Fire Retardant Intumescent Wrap Strips:** Foil backed, intumescent wrap strips
 - 1. **Acceptable Manufacturers and Products:**
 - a. Specified Technologies Inc: SpecSeal WrapStrip
 - b. 3M: FS 195 Fire Barrier Wrap Strip
 - c. Tremco: Tremstop
 - d. Rectorseal: Metawrap 60

- G. **Firestop Forming Materials Complying with UL XHKU**
 - 1. **Acceptable manufacturers:**
 - a. Manville Building Insulation, Schuller International, Inc.
 - b. USG Interiors Inc.
 - 2. Temporary Forms: Type X gypsum board
- H. **Accessories:** Provide accessories required by manufacturer, UL or other testing agency, and classification for specific application.
 - 1. Retaining Collars: Manufacturer's standard
 - 2. Steel wire, wire mesh, clips, sleeves, anchoring devices, primers, and other materials
 - 3. Metal Sheets and Shapes: Size and thickness as required by fire resistant system
- I. Firestopping material shall be asbestos-free and capable of maintaining an effective barrier against flame, smoke and gasses in compliance with the requirements of ASTM E814, and UL1479.
- J. Materials shall be suitable for the firestopping of penetrations made by steel, copper, plastic, and insulated pipe.
- K. On insulated pipe, the fire-rating classification must not require removal of the insulation.
- L. The rating of the firestops shall be not less than the rating of the time-rated floor or wall assembly.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean surfaces to be in contact with firestopping materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting or the required fire resistance.

3.2 INSTALLATION

- A. Install firestopping materials as indicated, in accordance with manufacturer's instructions.
- B. Prime surfaces as recommended by manufacturer.
- C. Seal all holes or voids made by penetrations to ensure an effective smoke barrier.
- D. Unless protected from possible loading, install firestopping materials in floors having void openings of (4) four inches or more to support the same floor load requirements.
- E. Tool material after application but before skin forms, to a smooth surface.
- F. Protect seals from disturbance for 48 hours.

3.3 FIELD QUALITY CONTROL

- A. Examine firestopped areas to ensure proper installation prior to concealing or enclosing firestopped areas.
- B. Areas of work shall remain accessible until inspection and approval by the applicable code authorities.

END OF SECTION

SECTION 078443

JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints in smoke barriers.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.5 COORDINATION

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."

2.2 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

- B. **Joints in or between Fire-Resistance-Rated Construction:** Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. **Joints in Smoke Barriers:** Provide fire-resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg.
 - 1. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.
- D. **Exposed Joint Firestopping Systems:** Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. **Accessories:** Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Surface Cleaning:** Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. **Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods.** Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:
 - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTION

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION

SECTION 079200
JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. **Section Includes:**

1. **Silicone joint sealants.**
2. **Urethane joint sealants.**
3. **Latex joint sealants.**
4. **Preformed joint sealants.**
5. **Acoustical joint sealants.**

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.4 SUBMITTALS

- A. **Product Data:** For each joint-sealant product indicated.
- B. **Sustainable Submittal:**
1. Product data for sealants and sealant primers, including printed statement of VOC content.
- A. **Samples for Initial Selection:** Two samples, 1/4 inch diameter x 4 inches in size illustrating color selections available.
- C. **Joint-Sealant Schedule:** Include the following information:
1. Joint-sealant application, joint location, and designation.
 2. Joint-sealant manufacturer and product name.
 3. Joint-sealant formulation.
 4. Joint-sealant color.
- D. **Product Certifications:** Submit manufacturers certification that joint sealants that are in contact with air barrier specified by Section 072726 - Fluid-Applied Membrane Air Barriers are compatible and will not void warranties.
- E. **Product Test Reports:** Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- F. **Field-Adhesion Test Reports:** For each sealant application tested.

1.5 **QUALITY ASSURANCE**

- B. **Manufacturer:** Company specializing in manufacturing the products specified in this Section with **minimum 10 years documented experience**.
- A. **Installer Qualifications:** Manufacturer's authorized representative who is trained and **approved for installation of units required for this Project, with minimum 10 years documented experience**.
- B. **Source Limitations:** Obtain each kind of joint sealant from single source from single manufacturer.
- C. **Mockups:** Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 **PROJECT CONDITIONS**

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 **WARRANTY**

- A. **Special Installer's Warranty:** Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. **Warranty Period: Three years** from date of Substantial Completion.
- B. **Special Manufacturer's Warranty:** Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. **Warranty Period: 20 years** from date of Substantial Completion for silicone sealants.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 **MATERIALS, GENERAL**

- A. **Compatibility:**
 - 1. Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
 - 2. Provide compatible joint sealants that are in contact with air barrier specified by Section 072726 - Fluid-Applied Membrane Air Barriers that are approved by air barrier manufacturer and does not void warranty.
- B. **VOC Content of Interior Sealants:** Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. **Liquid-Applied Joint Sealants:** Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
1. **Suitability for Immersion in Liquids:** Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- D. **Stain-Test-Response Characteristics:** Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. **Suitability for Contact with Food:** Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- F. **Colors of Exposed Joint Sealants:** As selected by Architect from manufacturer's full range.
- 2.2 **SILICONE JOINT SEALANTS**
- A. **Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant (S-GP) :** ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omniseal 50.
 - b. Dow Corning Corporation; 795.
 - c. GE Advanced Materials - Silicones; SilGlaze II SCS2800.
 - d. Pecora Corporation; 864.
- B. **Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant (S-S):** ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. BASF Building Systems; Omnipus.
 - b. Dow Corning Corporation; 786 Mildew Resistant.
 - c. GE Advanced Materials - Silicones; Sanitary SCS1700.
 - d. Tremco Incorporated; Tremsil 200 Sanitary.
- 2.3 **URETHANE JOINT SEALANTS**
- A. **Multi-component, Non-sag, Urethane Joint Sealant (U-MC):** ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; Dynatrol II.
 - b. Polymeric Systems, Inc.; PSI-270.
- B. **Multi-component, Self-Leveling, Traffic-Grade, Urethane Joint Sealant (U-TB):** ASTM C 920, Type M, Grade SL, Class 50, for Use T.
1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. Polymeric Systems, Inc.; PSI-270.
 - b. Tremco Incorporated; Dymeric 240 FC.
 - c. Pecora; Dynatread.
- 2.4 **LATEX JOINT SEALANTS**
- A. **Latex Joint Sealant (AL):** Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:

- a. BASF Building Systems; Sonolac.
- b. Bostik, Inc.; Chem-Calk 600.
- c. May National Associates, Inc.
- d. Pecora Corporation; AC-20+.
- e. Tremco Incorporated; Tremflex 834.

2.5 PREFORMED JOINT SEALANTS

- A. **Preformed Foam Joint Sealant (PF):** Manufacturer's standard preformed, pre-compressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in pre-compressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

- 1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. EMSEAL Joint Systems, Ltd.; Emseal 25V.
 - b. Sandell Manufacturing Co., Inc.; Polyseal.
 - c. Willseal USA, LLC; Willseal 150.
 - d. MM Systems, Color Joint Silicone
 - e. BASF, WABO Weather Seal II

2.6 ACOUSTICAL JOINT SEALANTS

- A. **Acoustical Joint Sealant (AC):** Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

- 1. **Acceptable Products:** Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; AC-20 FTR.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.

2.7 MISCELLANEOUS MATERIALS

- A. **Primer:** Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. **Cleaners for Nonporous Surfaces:** Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. **Masking Tape:** Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.
- D. **Backer Rod:**
 - 1. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing
 - 2. **Elastomeric Tubing Sealant Backings:** Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance
 - 3. **Bond-Breaker Tape:** Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Surface Cleaning of Joints:** Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. **Nonporous joint substrates include the following:**
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. **Joint Priming:** Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. **Masking Tape:** Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. **General:** Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. **Sealant Installation Standard:** Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
 4. **Measure joint dimensions and size materials to achieve required width/depth ratios.**
 5. **Install joint backing (if required) to achieve a neck dimension no greater than 1/3 the joint width.**
- C. **Test sealant application to substrate before installation. Ensure proper adhesion is achieved prior to proceeding with the Work.**
- D. **If substrate has a rough texture and an appropriate seal cannot be achieved, clean rough surface and force float sealant into voids providing a smooth surface first. Allow initial application to cure, and then install final application of sealant. Water test final installation of a test location for proper seal prior to proceeding with remainder of the sealant work.**
- E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- F. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
- H. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 **FIELD QUALITY CONTROL**

- A. **Field-Adhesion Testing:** Field test joint-sealant adhesion to joint substrates as follows:
1. **Extent of Testing:** Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and

- joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
 - 2. **Test Method:** Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 - 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. **Evaluation of Field-Adhesion Test Results:** Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- 3.5 **CLEANING**
- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.
- 3.6 **PROTECTION**
- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.
- 3.7 **JOINT-SEALANT SCHEDULE**
- A. **Sealant Schedule:**
- 1. **Exterior locations:**
 - a. **Wall joints:**
 - 1) **Bordered on both sides by porous building material** (concrete, stone, masonry, exterior insulation and finish systems): Designation S-GP; PF
 - 2) **Bordered on both sides by non-porous building material** (coated and uncoated metals, anodized aluminum, porcelain tile, and glass): Designation S-GP; PF
 - 3) **Bordered on one side by porous building material** (concrete, stone, masonry) and other side by non-porous building material (coated and uncoated metals, anodized aluminum, porcelain tile, and glass): Designation

S-GP; PF

- b. **Perimeter of penetrations through walls:** Designation S-GP
 - c. **Control joints (filling of V-grooves) and perimeter of penetrations in Portland cement plaster walls:** Designation S-GP.
 - d. **Expansion joints in ceilings, soffits, and overhead surfaces:** Designation S-GP
 - e. **Control joints and perimeter of penetrations in ceilings, soffits, and overhead surfaces:** Designation S-GP
 - f. **Wall and ceiling joints between frames and their rough opening:** Designation S-GP.
 - g. **Wall and ceiling joints between frames and adjoining surfaces:** Designation S-GP.
 - h. **Joints and perimeter of penetrations in horizontal pedestrian and vehicle traffic surfaces:** Designation U-TB.
 - i. **Joints in Division 07 Section 07 "Sheet Metal Flashing and Trim:"** Designation S-GP.
2. **Interior Joints:**
- a. **Wall and ceiling joints subject to movement:** Designation U-MC.
 - b. **Wall and ceiling joints not subject to movement:** Designation AL.
 - c. **Interior side of exterior openings:** U-MC.
 - d. **Floor joints:** Designation U-TB.
 - e. **Wall and ceiling joints between frames and their rough opening:** Designation AL.
 - f. **Wall and ceiling joints between frames and adjoining surfaces:** Designation AL.
 - g. **Interior Sanitary Joints; Joints Between Plumbing Fixtures and Adjoining Floor, Wall, and Ceiling Surfaces; Joints Between Shower Door Enclosure Components and Adjacent Finish Surfaces; Joints in Dietary and Food Preparation Areas, Kitchens, Food Storage Areas, and Areas Subject to Frequent Wet Cleaning, including joints between walls and floors, Joints Between Back Splashes and Wall Substrates:** Designation S-S.

END OF SECTION

SECTION 081113

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 **SECTION INCLUDES**
 - A. **Fire rated and non-rated rolled steel flush doors, frames with square corners and edges and associated glazing.**
- 1.3 QUALITY ASSURANCE
 - A. Conform to requirements of SDI-100.
 - B. **Manufacturer:** Company specializing in manufacturing the Products specified in this section with **minimum ten years experience**.
 - C. Installed frame and door assembly to conform to UL 10C for fire rated class indicated or scheduled.
- 1.4 SUBMITTALS
 - A. **Submit shop drawings**, and manufacturer's installation instructions, under provisions of Section 013300.
 - B. Indicate frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement, and finish.
 - C. Indicate door elevations, internal reinforcement, closure method, and cut outs for glazing.
 - D. Manufacturer's Installation Instructions: Indicate special installation instructions.
 - E. **Submit manufacturer's product literature.**
- 1.5 DELIVERY, STORAGE AND PROTECTION
 - A. Protect products under provisions of Section 016000.
 - B. Accept doors on site in manufacturer's packaging. Inspect for damage.
 - C. Break seal on-site to permit ventilation.
- 1.6 FIELD MEASUREMENTS
 - A. Verify that field measurements are as indicated on shop drawings.
- 1.7 COORDINATION
 - A. Coordinate work under provisions of Section 013200.
 - B. Coordinate the work with door opening construction, door frame and door hardware installation.

PART 2 - PRODUCTS

- 2.1 **ACCEPTABLE MANUFACTURERS - DOORS AND WELDED UNIT FRAMES**
 - A. **Curries.**
 - B. **Ceco Corporation.**
 - C. **Trussbilt.**
 - D. Substitutions: Under provisions of Section 016000.

2.2 DOORS AND FRAMES

- A. **Exterior Doors:** SDI-100 **Grade III – Heavy Duty**, Model 2 - Seamless, **flush panel insulated, 16 gage**, galvanized with rain cap
- B. **Interior Doors:** SDI-100 **Grade II – Heavy Duty** Model 2 - Seamless, **18 gage, flush panel doors**.
- C. **Door Frames - Exterior:** **14 gage, welded**, galvanized
- D. **Door Frames - Interior (fire rated):** **16 gage welded**.
- E. **Basis of Design:** Ceco Door SQ Series frames with square edges and corners.
- F. **Profile Dimensions:**
 - 1. **Backbends:** ¼" backbends exposed beyond specified wall finish.
 - 2. **Rabbets:** Equal 15/16" rabbets each side of soffit.
 - 3. **Stops:** ½" deep.
 - 4. **Face Frame Dimension:** 2" wide.

2.3 DOOR CORE

- A. **Core Types**
 - 1. **Fire Rated Doors:** Mineral fiberboard.
 - 2. **Non-Rated Doors:** Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, mineral-board, or vertical steel-stiffener core that produces doors complying with ANSI A250.8.
- B. **Provide fire-rated cores as scheduled and as required to meet all applicable codes, whether or not called for on Drawings.**

2.4 ACCESSORIES

- A. **Rubber Silencers:** Resilient rubber.
- B. **Glazing Stops:** Rolled steel channel shape, mitered corners; prepared for countersink style tamperproof screws.
- C. **Anchors:** Three per jamb, typically, of type to suit supportive construction.

2.5 FABRICATION

- A. Fabricate frames as welded unit. **Grind welds smooth prior to delivery.**
- B. Fabricate frames and doors with hardware reinforcement plates (for locks, closers, and other items attached to doors and frames) welded in place. Provide mortar guard boxes.
- C. **Reinforce frames wider than 48 inches with roll formed steel channels fitted tightly into frame head, flush with top.**
- D. Prepare frame for silencers. Provide three single rubber silencers for single doors on strike side, and two single silencers on frame head at double doors without mullions.
- E. Attach fire rated label to each fire-rated frame and door unit.
- F. Close top edge of exterior door flush with inverted steel channel closure. Seal joints watertight.
- G. **Provide fire rated doors and frames as required to meet all applicable codes, whether or not called for on Drawings.**

2.6 FINISH

- A. **Manufacturer's standard baked-on primer.**
- B. Refer to 099100 for final finish.
- C. **Note: All hollow metal doors and frames shall be spray painted, not brushed. No exceptions.**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify substrate conditions under provisions of Section 013200.
- B. Verify that opening sizes and tolerances are acceptable.

- C. Verify surfaces and conditions are ready to receive work of this section. Notify Architect of any existing conditions which will adversely affect execution. Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION

- A. Install frames in accordance with SDI-105 and reference U.L. publication.
- B. Install doors in accordance with DHI and reference U.L. publication.
- C. Coordinate with adjacent construction for anchor placement.
- D. Coordinate and provide for installation of glass and glazing as indicated on Drawings and required by code.
- E. Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.
- F. Set frames plumb, level, and true alignment, securely fastened to the floor and adjoining walls.
- G. Install doors accurately in frames, maintaining specified clearances.

3.3 TOLERANCES

- A. Maximum Diagonal Distortion: 1/8 inch measured with straight edge, corner to corner.

3.4 ADJUSTING AND CLEANING

- A. Adjust hardware and door movement for smooth, quiet and balanced door movement.

END OF SECTION

SECTION 081216

INTERIOR ALUMINUM FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. **Section Includes:**

1. Fire rated and unrated pre-finished aluminum door and side light frames for interior use (Not for use at exterior vestibules).

1.2 SUBMITTALS

- A. **Product Data:** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each product specified.
- B. **Shop Drawings:** Show fabrication and installation details. Include plans, elevations, sections, and details of components including hardware, glazing, and glazing stops. Show attachments to other Work.
- C. **Samples:** For each type of exposed finish required, prepared on Samples of manufacturer's standard sizes and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1.3 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has a **minimum of 10 years experience** installing interior aluminum framing systems similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **Manufacturer Qualifications:** A firm with a **minimum of 10 years experience** in manufacturing interior aluminum framing systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. **Source Limitations:** Obtain aluminum frames through one source from a single manufacturer with the capacity and resources to provide products of consistent quality in appearance and physical properties.
- D. **Fire-Rated Door Frames:** Frames complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated below, based on testing according to NFPA 252.
 1. **Provide at locations scheduled on Drawings and as otherwise required by code, and local authorities having jurisdiction, whether or not shown on Drawings.**

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver frames palletted, wrapped, or crated to provide protection during transit and job storage.
- B. Inspect frames on delivery for damage. Minor damages may be repaired provided refinished items match new work and are approved by Architect; otherwise, remove and replace damaged items as directed.
- C. Store frames at building site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

1.5 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not install interior aluminum frames until spaces are enclosed and weatherproof; wet work in spaces is complete and dry; flooring, walls, ceilings, and work above ceilings is complete; and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

- B. **Field Measurements:** Verify interior aluminum frame dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. **Products:** Subject to compliance with requirements, provide one of the products specified for each designation in the Door Schedule and Hardware Schedule in the Documents.
- B. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1. Raco.
 - 2. Advanced Architectural Frames.
 - 3. Frameworks Manufacturing by ASSA ABLOY.
 - 4. Modulex, Inc; Division of Pacific National Group.
 - 5. Versatrac.
 - 6. Wilson Partitions.
- C. **Basis of Design:** Raco; Solutions II with fixed throat to accommodate partition frame system with 2" trim and face.
- D. Provide 20 minute fire rated frames at locations in Atrium as required by codes.
- E. **Substitutions:** Under provisions of Section 016000.

2.2 MATERIALS

- A. **Extruded Aluminum:** ASTM B 221 (ASTM B 221M) alloy 6063-T5 or alloy and temper required to suit structural and finish requirements.

2.3 COMPONENTS

- A. **General:** Provide interior aluminum frame components that comply with dimensions and profiles indicated on drawings and this Section.
 - 1. **Rabbets:** Equal 1-15/16" rabbets on each side of soffit.
 - 2. **Stops:** 1/2" deep.
 - 3. **Face:** 2" wide.
- B. **Door Frames:** Extruded aluminum, not less than 0.062 inch (1.6 mm) thick, reinforced for hinges and strikes.
- C. **Glass Frames:** Extruded aluminum, not less than 0.062 inch (1.6 mm) thick, designed for glass thickness indicated.
- D. **Trim:** 2" face extruded aluminum, not less than 0.062 inch (1.6 mm) thick, removable snap-in glass stops and door stops without exposed fasteners.

2.4 ACCESSORIES

- A. **Fasteners:** Aluminum, nonmagnetic stainless-steel or other non-corrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. **Door Silencers:** Manufacturer's standard mohair or vinyl.
- C. **Glazing Gaskets:** Manufacturer's standard extruded or molded plastic, to accommodate 6-mm thick glass.
- D. **Glazing:** As specified in Division 8 Section "Glazing."
- E. **Hardware:** As specified in Division 8 Section "Door Hardware."

2.5 FABRICATION

- A. Machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within frame with concealed screws.
- B. Provide concealed corner reinforcements and alignment clips for precise butt or mitered connections.

- C. Fabricate frames for glass to allow glass replacement without dismantling frame.
- D. Fabricate components to allow secure installation without exposed fasteners.
- E. **At fire rated frames, provide steel reinforcement as required by manufacturer to achieve the fire ratings called for on the partitions in which the rated frames occur.**

2.6 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. **Final Finish:** To be selected by Architect from the following:
 - 1. **Clear Anodic Finish:** AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - 2. **Color Anodic Finish:** AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
 - 3. **High-Performance Organic Finish:** Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 4. **Color and Finish:** Refer to Section 008900.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and ceilings for suitable conditions where interior aluminum frames are to be installed.
- B. **Verify that wall thickness does not exceed standard tolerances allowed by throat size of frame based upon partition type frame is shown to be inserted on to plans. Provide frame throat size as required to accommodate the partition type called for on plans.**
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with frame manufacturer's written installation instructions and approved Shop Drawings.
- B. Install frames plumb and square, securely anchored to substrates with fasteners recommended by frame manufacturer.
- C. Install partition components in the longest possible lengths; **components up to 12 feet long must be one piece.** Fasten to adjacent construction on maximum 36-inch(914-mm) centers, using sheet metal screws or other fasteners approved by frame manufacturer.
 - 1. Use concealed installation clips to ensure that splices and connections are tightly butted and properly aligned.
 - 2. Secure clips to main structural extrusion components and not to snap-in or trim members.
 - 3. **Do not leave screws or other fasteners exposed to view when installation is complete.**

3.3 CLEANING AND ADJUSTING

- A. Clean exposed frames promptly after installation, using cleaning methods recommended by frame manufacturer.
 - 1. Clean and maintain anodized aluminum according to AAMA 609.
- B. Touch up marred areas so touchup is not visible from a distance of 12 inches. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

3.4 PROTECTION

- A. Provide protection required to ensure that framing will be without damage or deterioration on Substantial Completion.

END OF SECTION

SECTION 081416

FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:**
 - 1. **Solid-core doors with wood-veneer faces.**
 - 2. **Factory finished flush wood doors.**
 - 3. **Factory fitting flush wood doors to frames and factory machining for hardware.**

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Product Data:** For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- C. **Shop Drawings:** Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate requirements for veneer matching.
 - 4. Indicate doors to be factory finished and finish requirements.
 - 5. Indicate fire ratings for fire doors.
- D. **Samples for Verification:**
 - 1. **Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.** For each wood species and transparent finish, **provide set of three samples** showing typical range of color and grain to be expected in the finished work.
 - 2. **Corner sections of doors, approximately 8 by 10 inches,** with door faces and edgings representing typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.
 - 3. **Frames for light openings,** 6 inches long, for each material, type, and finish required.

1.4 QUALITY ASSURANCE

- A. **Source Limitations:** Obtain flush wood doors through one source from a single manufacturer.
- B. **Quality Standard:** **Comply with AWI's "Architectural Woodwork Quality Standards Illustrated," Premium Grade.**
 - 1. **Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of Premium Grade.**
- C. **Fire-Rated Wood Doors:** Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. **Test Pressure:** After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40 inches or less above the sill.
 - 2. **Oversize, Fire-Rated Wood Doors:** For door assemblies exceeding sizes of tested assemblies, provide oversize fire door label or certificate of inspection, from a testing and inspecting agency acceptable to authorities having jurisdiction, stating that doors comply with requirements of design, materials, and construction.
 - 3. **Temperature-Rise Rating:** At exit enclosures, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure.

4. **Positive Pressure Testing:** Comply with UL#10C.
- D. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in Division 01 Section 013100 "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

- A. **Special Warranty:** Manufacturer's standard form, signed by manufacturer, Installer, and Contractor, in which manufacturer agrees to repair or replace doors that are defective in materials, veneer quality or workmanship, have warped (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section, or show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 2. **Warranty** shall be in effect during the following period of time from date of Substantial Completion:
 - a. **Solid-Core Interior Doors: Life of installation.**

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers:**
1. **Algoma Hardwoods Inc.**
 2. **Eggers Industries; Architectural Door Division.**
 3. **GRAHAM Manufacturing Corp.**
 4. **VT Industries Inc.**

2.2 DOOR CONSTRUCTION, GENERAL

- A. Doors for Transparent Finish:
1. **Grade: Premium Grade, AWI certified,** with Grade A faces.
 2. **Species and Cut:** Match Architect's control Sample. Refer Section 008900 – Finish Selection Summary.
 3. **Assembly of Veneer Leaves on Door Faces:** Balance match.
 4. **Pair and Set Match:** Provide for doors hung in same opening or separated only by mullions.
 5. **Room Match:** Match door faces within each separate room or area of building. Corridor door faces shall match.
 6. **Stiles:** Applied wood-veneer edges of same species as faces and covering edges of faces.
 7. **Finish:** Match Architect's control sample.

2.3 SOLID-CORE DOORS

- A. **Particleboard Cores:** Comply with the following requirements:
1. Particleboard: ANSI A208.1, Grade LD-2.
 2. Provide doors with glued-block cores instead of particleboard cores at locations where exit devices are indicated.

- B. **Interior Veneer-Faced Doors:**
 - 1. **Core: Particleboard.**
 - 2. **Construction: Seven plies** with stiles and rails bonded to core, then entire unit abrasive planed before veneering.
- C. **Fire-Rated Doors:**
 - 1. **Construction:** Construction and core specified above for type of face indicated or manufacturer's standard mineral-core construction as needed to provide fire rating indicated.
 - 2. **Blocking:** For mineral-core doors, provide composite blocking with improved screw-holding capability approved for use in doors of fire ratings indicated as follows:
 - a. 5-inch top-rail blocking.
 - b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch midrail blocking, in doors indicated to have armor plates.
 - d. 5-inch midrail blocking, in doors indicated to have exit devices.
 - 3. **Edge Construction:** Provide edge construction with intumescent seals concealed by outer stile matching face veneer, and laminated backing at hinge stiles for improved screw-holding capability and split resistance.
 - 4. **Pairs:** Provide fire-rated pairs with fire-retardant stiles matching face veneer that are labeled and listed for kinds of applications indicated without formed-steel edges and astragals. **Provide stiles with concealed intumescent seals.**
- D. **Fire Astragals: Provide as required at all pairs of fire-rated doors.** Confirm profiles with Architect prior to fabrication.

2.4 LOUVERS AND LIGHT FRAMES

- A. **Wood Beads for Light Openings in Wood Doors:**
 - 1. **Wood Species:** Same species as door faces.
 - 2. **Profile:** Manufacturer's standard shape.
 - 3. **At 20-minute, fire-rated, wood-core doors,** provide wood beads and metal glazing clips approved for such use.

2.5 FABRICATION

- A. **Factory fit doors to suit frame-opening sizes indicated,** with the following uniform clearances and bevels, unless otherwise indicated:
 - 1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements in NFPA 80 for fire-rated doors.
- B. **Factory machine doors for hardware that is not surface applied.** Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 - 1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 - 2. **Metal Astragals:** Pre-machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. **Openings:** Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.
 - 1. **Light Openings:** Trim openings with moldings of material and profile indicated, or if none indicated, confirm with Architect.

2.6 FACTORY FINISHING

- A. **General:** Comply with AWI's "Architectural Woodwork Quality Standards Illustrated" for factory finishing.
- B. **Finish doors at factory to match Architect's Control Sample.**
- C. **Transparent Finish:**
 - 1. **Grade: AWI Certified Premium Grade.**
 - 2. **Finish:** AWI System TR-3 Water-based acrylic lacquer.
 - 3. **Staining and Sheen:** Stain as selected by Architect.

4. **Match Architect's control sample.**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Examine doors and installed door frames before hanging doors.**
 - 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. **Reject doors with defects and/or unattractive grain patterns. Architect shall be sole judge of aesthetic qualities and shall determine final acceptance.**
 - 3. **Verify AWI Premium Grade certification has been received.**
- B. **Proceed with installation only after unsatisfactory conditions have been corrected.**

3.2 INSTALLATION

- A. **Hardware:** For installation, see Division 08 Section "Door Hardware."
- B. **Manufacturer's Written Instructions:** Install doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
 - 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- C. **Factory-Fitted Doors:** Align in frames for uniform clearance at each edge.
- D. **Factory-Finished Doors:** Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. **Operation:** Re-hang or replace doors that do not swing or operate freely.
- B. **Finished Doors:** **Replace doors that are damaged, do not match Architect's Control Sample, or do not comply with AWI Premium Grade requirements.** Architect shall be sole judge of whether doors meet aesthetic requirements and Control Sample called for in this Section. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 081700

INTEGRATED DOOR OPENING ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes: Integrated door openings assemblies including metal frame, integrated door system with operating hardware, and associated door hardware as specified in this section.

1.4 SUBMITTALS

- A. **Product Data:** Manufacturer's product data sheets including integrated opening assemblies construction and installation details, material descriptions, core descriptions, hardware reinforcements, profiles, anchorage, fire resistance rating, operational descriptions and finishes.
- B. **Shop Drawings:** Include the following:
 - 1. Elevations of each door design.
 - 2. Details of door and frames types including dimensioned profiles and metal thicknesses.
 - 3. Locations of reinforcement and preparations for hardware.
 - 4. Details of anchorages, joints, field splices, and connections.
 - 5. Details of accessories.
 - 6. Details of moldings, removable stops, and glazing.
 - 7. Details of conduit and preparations for power, signal, and control systems.
 - 8. Provide all dimensions necessary required to complete recessed pockets.
- C. **Operating and Maintenance Manuals:** Provide manufacturers operating and maintenance manuals for each item comprising the complete integrated assembly installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the installed assemblies and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- D. **Warranties and Maintenance:** Special warranties and maintenance agreements specified in this Section.

1.5 QUALITY ASSURANCE

- A. Quality Standard: In addition to requirements specified, comply with ANSI A156.32, latest edition, "Integrated Door Opening Assemblies".
- B. Standards: All hardware specified herein to comply with ANSI/BHMA Certified Product Standards, A156 Series.
- C. Supplier Qualifications: Factory authorized distributor of manufacturer(s) systems and products. Submit written documentation upon request.
- D. Installer Qualifications: Installers acceptable by the primary assembly manufacturer, with a minimum three years documented experience installing both standard and electrified integrated door opening assemblies similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:

1. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
 - 1). Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - 2). Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
 - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 2. NFPA 101: Comply with the following for means of egress doors:
 - 1). Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 - 2). Thresholds: Not more than 1/2 inch high.
 3. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.
 - 1). Test Pressure: Positive pressure labeling.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to the project site under provisions Division 01 Section "Product Storage and Handling Requirements". Inspect doors, frames, and hardware with representatives of the supplier to verify shipment is complete and to rectify discrepancies promptly.
 1. Integrated door assembly systems to be delivered to the job site complete with necessary screws, miscellaneous parts, instructions, and installation templates. Each package legibly and properly labeled to correspond to the approved Door Schedule.
 - B. Furnish integrated door opening assemblies with operating hardware flush to door skin, using protective wrappings and spacers between projecting hardware. Maintain and protect door assemblies using cardboard spacers and protective edge guards along the door edges, to reduce exposure to marring or damage during storage.
 - C. Store integrated door opening assemblies in dry and secure area. Do not store electronic access control software, credentials, or accessories at Project site without prior authorization.
- 1.7 PROJECT CONDITIONS
- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.
- 1.8 WARRANTY
- A. **Special Warranty Periods:** Manufacturer's standard written form, with the exceptions noted below, warranting integrated door opening assemblies to be free of defect in material or workmanship under normal use for a period of five (5) years.
 1. **Continuous Hinges:** Ten (10) years.
 2. **Door Closers:** Ten (10) years.
 - B. Warranty includes the manufacturer, at their sole option, agreeing to repair or replace products or parts found to be defective in material or workmanship according to details contained in the warranty certificate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Adams Rite Manufacturing (AR) - The RITE Door.

2.2 MATERIAL REQUIREMENTS

A. Doors and Frames:

1. **Doors:** 1-3/4" thickness, with no visible seams or spot welds on door face, conforming to manufacturer's standard integrated assembly system construction. Door face skins minimum 18 gauge, cold rolled steel, with either a Honeycomb or Polystyrene type core. Doors to be constructed with a U-shaped, 16 gauge steel reinforcement channel, top and bottom, for the installation of door hardware accessories and supplied with a 18 gauge top cap.
2. **Frames:** Minimum 16 gauge, ASTM A366 cold rolled steel, complying with ANSI/SDI A250.8. Furnish frames with mitered corners, continuously welded and ground smooth on frame face. Prepare frames with 14 gauge reinforcements for applied hardware and provide suitable adjustable type anchors for wall condition, minimum 4 each per jamb.
3. **Fire Rated Doors and Frames:** Fabricate in accordance with NFPA 80, listed and labeled by a qualified testing agency, for the fire protection ratings indicated.

B. Door Hardware:

1. Provide a complete integrated door opening assembly, including the installation and adjustment of the latching mechanism within the door construction.
2. Integrated exit device hardware to be clean and unobtrusive in design with a minimal bar height of 2-7/16-inches. Push rails not exceed a projection of 1-1/8-inches when in the latched position and be made of heavy duty aluminum extrusion, available in anodized and architectural finishes using metal cladding. Exit device end caps to be of metal construction.
3. Push and pull hardware to be clean and unobtrusive in design with a maximum projection of 1/4-inches on pull side and 5/8-inches on the push side.
4. Lever handles to be clean and unobtrusive in design with a maximum projection of 3-1/2-inches and match design of similar lever locking hardware furnished on project.
5. Door hardware to include the following minimum products for each integrated door opening assembly.
 - a. Hanging Device: Continuous Hinges (geared or pinned).
 - b. Integrated Locking/Latching Hardware: Exit Devices, Lever Handle Trim, or Flush Push/Pulls.
6. Door hardware may include the following optional products for each integrated door opening assembly as specified in the Door Hardware Sets under Part 3:
 - a. Door Closers: Surface Closer or Pocket Closer.
 - b. Accessory Items: Magnetic Holders, Protection Plates, Edge Guards, Astragals, Smoke Seals.

2.3 FINISH REQUIREMENTS

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- C. Finishes:
 1. Door Faces: Factory Pre-Finished.
 2. Frames: Factory Pre-Finished.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected. Beginning of installation indicates acceptance of the existing conditions.

3.2 INSTALLATION

- A. General: Install integrated door opening assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; integrated locking/latching devices; closing devices; and seals.
- C. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 3. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- D. Coordinate installation and interface wiring with fire alarm and smoke detection systems.
- E. Remove or protect furnished hardware accessories, prior to painting or finishing completed after the installation of the hardware accessories.

3.3 ADJUSTMENT AND CLEANING

- A. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Remove and replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.4 CLEANING AND PROTECTION

- A. Protect all door opening assemblies and hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install hardware at the latest possible time frame.
- B. Clean operating items as necessary to restore proper finish and provide final protection and maintain conditions that ensure integrated door and operating hardware is without damage or deterioration at time of owner occupancy.
- C. Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying finish paint.

END OF SECTION

SECTION 083113

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 **SECTION INCLUDES**
 - A. **Access door and frame units.**
 - B. **Floor, wall and ceiling locations.**
- 1.3 SUBMITTALS
 - A. Submit under provisions of Section 013300.
 - B. **Product Data:** Provide sizes, types, finishes, scheduled locations, and details of adjoining work.
- 1.4 REGULATORY REQUIREMENTS
 - A. Conform to applicable code for fire rated access units.
- 1.5 COORDINATION
 - A. Coordinate work under provisions of Section 013100.
 - B. Coordinate the work with mechanical and electrical work requiring access units.

PART 2 - PRODUCTS

- 2.1 **MANUFACTURERS - WALL AND CEILING UNITS**
 - A. Milcor, Inc.
 - B. J. L. Industries.
 - C. KARP, Associates.
 - D. Substitutions: Under provisions of Section 016000.
 - E. **Products listed herein are those of Milcor, Inc., as standard of quality.**
 - F. **Note: All of the following types may not be used on this project.**
- 2.2 **ACCESS UNITS - WALLS**
 - A. **Non-Fire Rated Door and Frame Unit:** Formed steel finish; Stainless steel at restroom walls.
 - 1. In Gypsum Board on Metal Studs: Model DW 3203 manufactured by Milcor.
 - B. **Fire Rated Door and Frame Unit:** Formed steel finish; Stainless steel at restroom walls. 1-1/2 hour UL B label fire rating
 - 1. In Gypsum Board on Metal Studs: Model 3218 manufactured by Milcor.
- 2.3 **ACCESS UNITS - CEILINGS**
 - A. **Non-Fire Rated Door and Frame Unit:** Formed steel; Stainless steel at restroom walls.
 - 1. In Gypsum Board on Metal Furring: Model DW 3203 manufactured by Milcor.
 - B. **Fire Rated Door and Frame Unit:** Formed steel, 1-1/2 hour B label fire rating
 - 1. In Gypsum Board on Metal Furring: Model 3218 manufactured by Milcor.
- 2.4 **ACCESS UNITS - EXTERIOR**
 - A. **Non-Fire Rated Door and Frame Unit:** Formed of stainless steel.
 - 1. Model NIFR manufactured by Milcor.

- 2.5 FABRICATION - WALL AND CEILING UNITS
 - A. Fabricate frames and flanges of 22 gage steel.
 - B. Fabricate door panels of 22 gage steel single thickness steel sheet.
 - C. Weld, fill, and grind joints to assure flush and square unit.
 - D. **Hardware**
 - 1. **Hinge:** 175 degree steel hinges with removable pin.
 - 2. **Lock:** Screw driver slot for quarter turn cam lock.
- 2.6 **FINISHES**
 - A. **Base Metal Protection:** Prime coat units with baked on primer. Final finish refer to 099100 and 008900.
 - B. **Stainless steel units at restroom and exterior wall locations.**

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Verify substrate conditions under provisions of Section 014300.
 - B. Verify that rough openings for door and frame are correctly sized and located.
- 3.2 INSTALLATION
 - A. Install units in accordance with manufacturer's instructions.
 - B. Install frames plumb and level in opening. Secure rigidly in place.
 - C. Position unit to provide convenient access to concealed work requiring access.
- 3.3 **SCHEDULE**
 - A. **Provide fire rated and non-fire rated access doors as required at all locations where required by code or the Owner including, but not limited to, HVAC units, plumbing valves, electrical junction boxes and other items requiring access.**
 - B. **Additionally, provide at all locations indicated on the Drawings.**

END OF SECTION

SECTION 083516

SIDE FOLDING GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. **Side-folding aluminum grilles.**
 - 2. Operating hardware and supports.

1.3 PERFORMANCE REQUIREMENTS

- A. All locking posts shall allow for horizontal sway without pressure to side walls of track from trollies while opening and closing the curtain.
- B. All post's standard locking hardware and handles shall be flush within post with exceptions for exit hardware.

1.4 SUBMITTALS

- A. **Product Data:** Provide information on grille construction, components, materials, and finishes.
- B. **Shop Drawings:** Indicate track layout and dimensions including pocket, required curves, types and locations of posts, required locking and hardware, options, finish and installation details.
- C. **Operation and Maintenance Data:** To include in emergency, operation, and maintenance manuals

1.5 WARRANTY

- A. Provide manufacturer's 2 year warranty against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:**
 - 1. **Manufacturer:** Dynamic Closures Corporation.
 - 2. **Product:** SL 12 CS Curtain.
- B. Other Acceptable Manufacturers: Subject to compliance with requirements herein, provide products from one of the following:
 - 1. CHI Overhead Doors.
 - 2. Overhead Door Corp.
 - 3. Wayne-Dalton Corp.

2.2 MATERIALS

- A. **Aluminum Extrusions:** ASTM B221, 6063-T5 or T6 alloy and temper.

2.3 COMPONENTS

- A. **Description:** 4.25 inches (108mm) wide with 2 inch (51mm) high bottom and top plates, truss-like aluminum, with alternating 12 inch (305mm) polycarbonate panels and 2 inch (51mm) solid aluminum panels in a checkerboard design. Panels connected with single-piece vertical 0.6125 x 0.5 inch (16mm) x (13mm) aluminum hinges
- B. **Operation:** Manual push/pull. Provide pull straps on openings over 9 feet (2743mm) in height and countertop applications.
- C. **Curtain Carriers:** Dual bearing trollies with 1.125 inch (29mm) diameter tires.

- D. **Overhead Track:** Extruded aluminum, 1.375 inches (35mm) wide x 1.675 inches (43mm) high, continuous profile seamed with alignment bars and track pins at splices.
- E. **Curves:** Detailed type and location on drawing if required.
- F. **Locking Post:** Extruded aluminum, all post's standard locking hardware and handles shall be flush within post with exceptions for exit hardware. Locks may be on the public side, secure side or both except for intermediate posts. All stainless steel lock rods engage stainless steel floor or counter sockets. All locking posts shall allow for horizontal sway without pressure to side walls of track from trollies while opening and closing the curtain. Refer to detailed drawing for location and type of posts. Post type and location detailed on drawing.
 - 1. **Wall Channel:** A floor to track extruded aluminum channel that the hookbolt fits and locks into. This channel is secured permanently to the wall.
 - 2. **HookBolt Lead:** This post has a hookbolt that secures it to the Wall Channel. Additional top locking or double hookbolt locking available.
 - 3. **Bi-Part:** A pair of posts that lock together with a hookbolt with an added lock rod to keep the curtain in place. It is used to separate larger doors into manageable sections, or to split the door to stack in two different directions. The concealed stainless steel lock rod engages into a floor or counter socket. Doors should have at least one Bi-Part for every 30 feet (9144mm) of width. Top stainless steel rod locking available.
 Top & Bottom: Lead or Trailing End option. This post contains spring loaded stainless steel lock rods that engage a floor or counter socket with the bottom rod and the top rod engages into the track and header. They are unlocked with a keyed cylinder, thumb turn or paddle, both disengaging in one motion. A rubber bumper is the standard leading edge but may also have a 4 inch (102mm) flange.
 - 4. **Intermediate:** A middle post in a door located between door sections, containing a spring-loaded stainless steel lock rod that engages a floor or counter socket to keep the door in place and unlocked by a keyed cylinder or a thumb turn. Maximum straight line spacing of all posts is 10 feet (3048mm). Curves and counter top applications will require closer spacing.
 Traveling End: The Traveling End post terminates a door inside of a pocket (storage area). It is free to travel back and forth inside of the pocket. The post self-locks into permanent header and floor stops that prevent the door from fully leaving the pocket. A rear flange attached to the back of the post prevents reaching around.
 Fixed End: Simply attaches the end of a door permanently to a wall of structure.
- G. **Emergency Egress Door:** Detailed latch type and location on drawing if required. Swing out 35.5 in. x 79.5 in. (902mm x 2019mm) emergency egress door within the curtain. Egress doors for open air Grilles are constructed with perforated panels. Egress doors for Closures are constructed of corresponding curtain material. Add 8 inches (203mm) to stack.

2.4 FINISHES

Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install assembly in accordance with manufacturer's instructions.
- B. Anchor to adjacent construction without distortion or stress, level and plumb, to provide smooth operation.

3.2 ADJUSTING

- A. Adjust grilles for smooth operation throughout full operating range.

END OF SECTION

SECTION 084113

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents: General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and Drawings are applicable to this Section.
- B. Section Includes:
 - 1. Aluminum storefront for use at weather protected recessed exterior openings, entrances, and interior uses only
 - 2. Anchors, brackets, and attachments.
 - 3. Aluminum door hardware.

1.2 SYSTEM DESCRIPTION AND PERFORMANCE

- A. Architectural Requirements
 - 1. Drawings are diagrammatic and do not purport to identify or solve problems of thermal or structural movement, glazing or anchorage.
 - 2. Requirements shown by details are intended to establish basic dimensions of units, sightlines and profiles of members.
 - 3. Provide concealed fastening only. No exceptions.
- B. Structural Requirements
 - 1. System to provide for expansion and contraction within system components caused by a cycling temperature range of 170 F degrees without causing detrimental effects to system or components.
 - 2. Design and size members to withstand dead loads and live loads caused by pressure and suction of wind as calculated in accordance with building code, and measured in accordance with ANSI/ASTM E 330.
 - 3. Limit mullion deflection to L/200, or flexure limit of glass with full recovery of glazing materials, whichever is less.
 - 4. System to accommodate, without damage to system or components, or deterioration of perimeter seal: Movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. Storefront manufacturer shall be responsible for design and engineering of storefront systems, including water drainage system and necessary modifications to meet specified requirements and maintaining visual design concepts.
 - 6. Attachment methods of frame at rough opening to be designed and engineered by storefront manufacturer's licensed engineer registered in the state in which the project is located. Consideration shall take into account site peculiarities, deflection of structure above storefront, and expansion and contraction movements so there is no possibility of loosening, weakening or fracturing connection between units and building structure or between units themselves.
 - 7. Design anchors, fasteners and braces to be structurally stressed not more than 50% of allowable stress when maximum loads are applied.
 - 8. Engineer storefront and entrances to be free from rattles, wind whistles and noise due to thermal and structural movement and wind pressure.
- C. Environmental Requirements
 - 1. Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to exterior. No water leakage shall occur in wall when tested in accordance with ASTM E 331 at test pressure of 6.24 pounds per square foot.
 - 2. Limit air infiltration through assembly to 0.06 cu ft/min/sq ft of assembly surface area, measured at a reference differential pressure across assembly of 6.24 lbs/sq ft. as measured in accordance with ANSI/ASTM E 283.

3. Maintain continuous air and vapor barrier throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound.

1.3 SUBMITTALS

- A. **Submit shop drawings and product data** under provisions of Section 013300.
- B. Include system and component dimensions; literature on components; framed opening requirements and tolerances; anchorage and fasteners; glass and infills; door hardware requirements; and affected related work.
- C. Submit manufacturer's installation instructions under provisions of Section 013300.
- D. Submit samples under provisions of Section 013300.
- E. Submit samples illustrating:
 1. (4) Pre-finished aluminum surface samples (4 by 4 inches).
 2. (1) Storefront section with specified glass (12 by 12 inches).
 3. (1) 8 x 8 inch door corner section with specified glass.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with AAMA SFM-1 and AAMA - Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual.
- B. Conform to requirements of ANSI A117.1, TAS, ADA and local accessibility amendments.
- C. Testing: Vacuum Chamber Water Pressure Testing shall be performed by the Owner's certified testing company on two door units and 10 percent of exterior window units or as otherwise determined by the Architect. Hose stream tests may be performed by the Architect with the assistance of the Contractor at additional locations as requested by the Architect. Testing for water infiltration will be conducted on the storefront system, storefront windows and doors, and entrance doors after installation of window/door, exterior veneer, and sealant have been completed. Leave interior side of drywall finishes off for a distance of 4 inches around frames for observation until testing has been satisfactorily completed.
- D. In addition, Architect and Contractor shall conduct a water dam test at storefront window sills. The purpose shall be to observe for water loss through joints between windows and adjacent finishes. Leave interior side finishes open for a distance of 6 inches around the entire water dam and sill for observation until testing has been satisfactorily completed.

1.5 QUALIFICATIONS

- A. **Manufacturer and Installer:** Company specializing in manufacturing aluminum glazing systems with **minimum 10 years documented experience.**

1.6 PRE-INSTALLATION CONFERENCE

- A. **Convene for a Pre-installation conference** one week prior to commencing work of this Section, under provisions of Section 013100.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and handle system components under provisions of Section 016000.
- B. Store and protect system components under provisions of Section 016000.
- C. Provide wrapping to protect prefinished aluminum surfaces.

1.8 COORDINATION

- A. Manufacturer shall be responsible for details and dimensions not controlled by job conditions and shall show on his shop drawings required field measurements beyond his control.
- B. Coordinate with responsible trades to establish, verify and maintain field dimensions and job conditions.

1.9 ENVIRONMENTAL CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F during and 48 hours after installation.

- 1.10 WARRANTY
- A. Provide 5 year warranty jointly signed by manufacturer and installer under provisions of Section 017839.
 - B. Warranty: Cover complete system for failure to meet specified requirements and finish.
- 1.11 FIELD MEASUREMENTS
- A. Verify that field measurements are as indicated on shop drawings and as instructed by the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements herein, provide products from one of the following: Basis of Design for Aluminum Fixed Windows: EFCO Corporation
 - 1. EFCO Corporation.
 - 2. Kawneer North America; an Alcoa company.
 - 3. Oldcastle BuildingEnvelope.

2.2 MATERIALS

- A. Extruded Aluminum: ANSI/ASTM B 221; 6060-T5 alloy, temper.
- B. Sheet Aluminum: ASTM B 209; 5005-H16 alloy, temper.
- C. Sheet Steel: ANSI/ASTM A 446; hot-dipped galvanized.
- D. Steel Sections: ANSI/ASTM A 36; shapes to suit mullion sections.
- E. Primer and Touch-Up Primer for Galvanized Surfaces: FS TT-P-645.
- F. Fasteners: Stainless steel.

2.3 FABRICATED COMPONENTS

- A. General: Form section true to details with clean, straight, sharply defined profiles, free from defects impairing strength or durability.
- B. **SF-1 Exterior Storefront System:** 2-1/4-inch by 4-1/2-inch profile as indicated on Drawings, 1 inch glazing, thermally broken, exterior pressure glazed (EPDM gasket), steel reinforced for entrances.
 - 1. **Basis of Design:** EFCO Corp; Series 403-I TS with aluminum back plate and top closure caps.
- C. **SF-2 Interior Storefront System:** 2 inch by 4-1/2 inch profile as indicated on Drawings. 1 inch glazing non-thermal broken with sound sealed gasket;
 - 1. **Basis of Design:** EFCO Carpi Series 402 NT with aluminum back plate.
- D. **Medium Stile Heavy Duty Reinforced Entrance Doors:** 3/16-inch thick walls with 1-3/4" thick x 3-1/2-inch wide vertical rails, 5-inch wide top rail, 10-inch wide bottom rail; welded corners; square glazing stops for insulated glass units; beveled glazing stops for single glazed units.
 - 1. **Basis of Design:** EFCO Corp; D300 Medium Stile Doors.
 - 2. Horizontal rails to be wide enough to contain panic hardware.
 - 3. Vertical stiles to be wide enough to contain vertical panic hardware release rods in double doors.
- E. **Flashings:** Form from sheet aluminum with same finish as extruded sections. Apply finish after fabrication. Material thickness as required to suit condition without deflection or "oil canning".
- F. High Performance Pan Sill Flashing: Install manufacturer's high performance sill flashing at all storefront window locations whether or not called for on the Drawings.

2.4 GLASS AND GLAZING MATERIALS

- A. Glass and Glazing Materials: As specified in Section 088000.

2.5 SEALANT MATERIALS

- A. Sealant and Backing Materials: As specified in Section 079200 of types described below

2.6 HARDWARE

- A. Refer Section 087100.
- B. Provide continuous geared hinges and recessed closers at all doors. Coordinate panic hardware with door locations.

2.7 FABRICATION

- A. Fabricate doors and frames allowing for minimum clearances and shim spacing around perimeter of assembly, yet enabling installation.
- B. Rigidly fit and secure joints and corners with internal reinforcement, except that **door corners will be welded**. Make joints and connections flush, hairline, and weatherproof.
- C. Provide only products with internal drainage systems directing all moisture to the exterior of the system and wall. System provided shall allow no water to deposit in the wall system or cavity wall adjacent to the installation.
- D. Prepare components to receive anchor devices. Fabricate anchorage items.
- E. Arrange fasteners, attachments, and jointing to ensure concealment from view.
- F. Prepare components with internal reinforcement for door hardware.
- G. Reinforce framing members for imposed loads and as required for wind loads.
- H. Fabricate window units with "end dams" at the sill and other locations as required to collect and direct water to the exterior of the system.
- I. Use of double vertical mullions at splayed windows is not permitted.

2.8 FINISHES

- A. **Refer to 008900 for finish as selected from the following:**
 - 1. **Clear Anodic Finish:** AAMA 611, AA-M12C22A21, Class I, 0.018 mm or thicker.
 - 2. **Color Anodic Finish:** AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - a. ~~Color: Refer to 008900.~~
 - 3. **High-Performance Organic Finish:** ~~2-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.~~
 - a. ~~Color: Refer to 008900.~~
- B. **Concealed Steel Items:** Galvanized in accordance with ANSI/ASTM A386 to 2.0 oz/sq ft.
- C. Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.
- B. Verify dimensions, tolerances, and method of attachment with other work.
- C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

- A. Install wall system, doors, and glazing in accordance with manufacturer's instructions and AAMA Procedural Guide for Certification of Window and Door Assemblies.
- B. Use anchorage devices to attach securely frame assembly to structure.
- C. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- D. Install manufacturer's high performance pan sill flashing at all locations. Provide end dams and ensure water is directed to the exterior of the system.
- E. Coordinate attachment and seal of air and vapor barrier materials.

- F. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
 - G. Install hardware using templates provided. Refer to Section 087100 for installation requirements.
 - H. Install glass in accordance with Section 088000, using exterior dry method of glazing.
 - I. Install perimeter polyurethane type sealant (Designation U-SC), backing materials, and installation requirements in accordance with Section 079200.
 - 1. Where installing aluminum window systems adjacent to rough surface clean and force float sealant into rough surface. Allow sealant to set per manufacturer's recommendations, then install aluminum window system and seal between aluminum window systems and smooth sealant surface.
 - J. Adjust operating hardware for smooth operation.
 - K. Use only concealed fasteners. No exposed screws or other types of fasteners will be allowed under any circumstances. Any storefront installed with exposed fasteners shall be removed and replaced at the Contractor's expense.
- 3.3 TOLERANCES
- A. Maximum Variation from Plumb: 0.06 inches every 3 feet non-cumulative or 1/16 inches per 10 feet, whichever is less.
 - B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
- 3.4 ADJUSTING
- A. Adjust work under provisions of Section 017700.
 - B. Adjust operating hardware for smooth operation.
- 3.5 CLEANING/REPAIRING/REPLACEMENT
- A. Remove protective material from pre-finished aluminum surfaces.
 - B. Wash down exposed surfaces using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
 - C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
 - D. Replace scratched, cracked, chipped or otherwise damaged glass and framing.
- 3.6 PROTECTION OF FINISHED WORK
- A. Protect finished work under provisions of Section 015000.
 - B. Protect finished work from damage.
- 3.7 SCHEDULE
- A. **SF-1 Exterior Storefront System:** Provide at exterior building entrances doors and door frames with 1" insulated glass units to match those used in curtainwall.
 - B. **SF-2 Interior Storefront System:** Provide at east 4 story Atrium at interior glazed walls with 1" insulated acoustical glazed units.

END OF SECTION

SECTION 084229

AUTOMATIC SLIDING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. Section Includes: Automatic aluminum sliding glass door assemblies for use at West Lobby Entrances.

1.3 SUBMITTALS

- A. **Product Data:** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for entrance doors.
- B. **Shop Drawings:** Include plans, elevations, sections, details, hardware mounting heights, and attachments to other Work.
- C. **Samples for Verification:** For each type of exposed finish required, prepared on Samples of size indicated below and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
 - 1. Size: 12 inch long sections of extrusions or formed shapes.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who is an authorized representative of the entrance door manufacturer for both installation and maintenance of units required for this Project with a minimum of **10 years' experience** installing specified products.
- B. **Air Infiltration:** According to ASTM E283-91:
 - 1. Standard Test Pressure @ 1.57 psf, measured 0.462 cfm/ft² (ASTM Allowable 1.20 cfm/ft²).
 - 2. Additional Test Pressure @ 6.24 psf, measured 1.052 cfm/ft².
- C. **Product Options:** Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, or in-service performance.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. **Welding Standards:** Comply with AWS D1.2, "Structural Welding Code--Aluminum."

1.5 PROJECT CONDITIONS

- A. **Field Measurements:** Verify entrance door openings by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.6 WARRANTY

- A. **Special Warranty:** Written warranty, executed by manufacturer agreeing to repair or replace components of the entrance door system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Lateral deflection of glass lite edges in excess of 1/175 of their length or 3/4 inch (75

- mm), whichever is less.
- 2. Faulty operation of hardware.
- 3. Deterioration of metals, metal finishes, and other materials beyond normal use.
- B. **Warranty Period:** Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design:
 - 1. Manufacturer: Horton Automatics, a division of Overhead Door Corporation.
 - 2. Product: Automatic Commercial Sliding Doors, Type 310.
- B. **Other Acceptable Manufacturers:** Subject to compliance with requirements, provide product by one of the manufacturers listed below:
 - 1. Besam Entrance Solutions.
 - 2. Dorma USA, Inc.
 - 3. Stanley Access Technologies; Div. of The Stanley Works.

2.2 SLIDING AUTOMATIC DOORS

- A. General: Manufactured door units shall include operator, header with roller track, carrier assemblies, framing jambs, sliding door panel(s), sidelite(s), activation, safety devices and accessories required for complete installation.
 - 1. **Configuration:** SO-SX-SX-SO.
 - 2. **Mounting Type:** Between jambs.
 - 3. **Floor Track Configuration:** No track across sliding-door opening and at sidelites (trackless).
 - 4. **Stile Design:** Medium stile; 3-1/2 inch nominal width.
 - 5. **Rail Design:** 5 inch nominal height.
 - 6. Glazing Stops and Gaskets: Beveled.
 - 7. **Glazing:** Clear tempered.
 - 8. **Finish:** Finish framing, door, sidelite, and header with Class II, clear anodic finish.
- B. **Operator:** The operator shall be mounted and concealed within the header.
 - 1. **Operating force** shall be accomplished through a 1/8 HP DC permanent magnet motor with worm gear transmission and 1800 RPM working with drive belt, attached door hangers, and idler pulley. Drive belt to be steel reinforced nylon, 1/2" (13 mm) wide. Idler pulley to be reinforced, metallic material.
 - 2. **Master Control** shall be 16 bit microprocessor controller with dual on-board seven-segment alphanumeric diagnostic display and position encoder. The encoder shall monitor revolutions of the operator shaft and send signals to microprocessor controller to define door position and speed. The control shall have minimum of 28 programmable parameters including the following functions as required by ANSI A156.10:
 - a. Adjustable opening and closing speeds.
 - b. Adjustable back-check and latching.
 - c. Adjustable braking.
 - d. Adjustable hold-open time between 1 to 30 seconds.
 - e. Adjustable Reversing Circuit will reopen door unit if closing path is obstructed.
 - f. Separate day and night modes of operation with security over-ride.
 - 3. **Finger Safety:** When unit slides open, strike rail of sliding panel will stop short of adjacent sidelite; resulting opening is net slide.
 - 4. **On/Off Switch** shall be supplied. When switched OFF, unit reverts to free manual operation (likewise during electrical power failure).
- C. Security and Safety Power Fail Options:
 - 1. **Automatic lock:** Automatically locks slide function of door when in closed position. Additional power supply for autolock not acceptable.
 - a. **Autolock Fail Safe:** If power fails the lock disengages.

2. Monitored Power Fail (battery back-up):

- a. **Software Selectable Power Fail Open:** If power fails the door slides open.
- D. **Header:** Shall be slim 4" (102mm) deep by 6" (152mm) high aluminum construction with extruded z-profile reinforcement for dead load and lateral strength. Header shall have removable face plate for service and adjustment of operator and controls. Header mounts flush to 4" framing jambs.
- E. **Carrier Assemblies and Header Roller Track:** Carrier assemblies shall support door panels with minimum four rollers per panel. Rollers will be steel, high quality ball bearing wheels 1-1/4" (32 mm) diameter. Anti-Derailing shall be accomplished by means of a continuous aluminum extrusion full length of slide panel travel. Overhead header roller track shall be continuous aluminum, nylon covered, and replaceable.
- F. **Hardware:** ANSI A156.5, Grade 1, 2-Point Locking provided and installed in strike rail shall include:
 - 1. Hookbolt Latch, 5/8" laminated stainless steel, latching into jamb or adjacent strike rail.
 - 2. 3/8" hex-bolt into breakout carrier frame.
 - 3. Keyed 1 5/32" (29 mm) Cylinder mounted on exterior side with 31/32" (25 mm) backset.
 - 4. Thumbturn mounted on interior side.
 - 5. Hardware Options:
 - a. Lock Position Indicator.
 - b. Cylinder Guard.
 - c. Cylinder Escutcheon.
- G. **Activation Sensors:** Microwave or active infrared sensor shall be header-mounted each side of door unit for detection of traffic from each direction.
- H. **Presence Sensors:**
 - 1. Header mounted sensors shall provide active infrared presence detection on each side of the door unit and shall remain active throughout the entire door opening and closing cycle.
 - 2. Hold-open beams: Two pulsed infrared photoelectric beams to be mounted in vertical rails of sidelite or in jambs. Sender/receiver arrangement parallels door opening.

2.3 RELATED WORK REQUIREMENTS

- A. **Electrical:** 120 VAC, 50/60 cycle, single phase, dedicated 20 amp circuit per operator. Non-North American voltages can be 240 VAC 50/60 cycle (operator must have 240 volt power supply).
- B. **Operator Construction:** Electromechanical, modular type construction.

2.4 MATERIALS

- A. **Aluminum:** Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with standards indicated below:
 - 1. Extruded: ASTM B 221 (ASTM B 221M).
 - 2. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - 3. Welding Rods and Bare Electrodes: AWS A5.10.
- B. **Glazing:** As specified in Division 8 Section "Glazing."
- C. **Sealants and Joint Fillers:** Refer to Division 7 Section "Joint Sealants" for joints at perimeter of entrance system.
- D. **Nonmetallic, Shrinkage-Resistant Grout:** Premixed, nonmetallic, non-corrosive, non-staining grout; complying with ASTM C 1107; of consistency suitable for application.
- E. **Bituminous Paint:** Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos; formulated for 30-mil (0.76-mm) thickness per coat.

2.5 DOOR ASSEMBLIES

- A. **General:** Provide manufacturer's standard door assembly, complete with doors, sidelite framing, and accessories as indicated. Comply with the following:
 - 1. **Number of Doors:** As indicated.

2. **Emergency Breakaway Capability:** Door only.
 3. **Floor Track Configuration:** Trackless across door opening and recessed, pin-guide track system at sidelites.
- B. **Opening Force:** Provide entrance doors that require no more than 5 lbf (22.2 N) to stop door movement.

2.6 COMPONENTS

- A. **Doors:** Provide manufacturer's standard 1-3/4-inch- (44.5-mm-) thick glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded tubular stile and rail members. Fabricate corners with mechanically fastened reinforcing brackets or by welding. Incorporate concealed tie-rods that span full length of top and bottom rails.
1. **Glazing Stops and Gaskets:** Provide manufacturer's standard snap-on, extruded-aluminum, square glazing stops and preformed resilient glazing gaskets.
 2. **Stile and Rail Design:** Match profile sizes and locations for the storefront entrances. Include 10 inch high bottom rail required for accessibility requirements.
- B. **Framing Members:** Fabricated from extruded-aluminum or formed-aluminum sheet or plate.
1. **Main Extrusions:** Minimum wall thickness of 0.125 inch (3.2 mm).
 2. **Extruded Glazing Stops and Applied Trim:** Minimum wall thickness of 0.062 inch (1.6 mm).
- C. **Headers:** Fabricated from minimum 0.125-inch- (3.2-mm-) thick, extruded aluminum or formed-aluminum sheet or plate. Conceal roller track in header, providing access by means of hinged or removable access panel to permit service and adjustment. Secure panel to prevent unauthorized access.
1. **Concealed:** Fabricate header to match depth of framing and to extend full width of door opening.
 2. **Capacity:** Capable of supporting doors up to 100 lb (45 kg) per leaf.
- D. **Carrier Assembly and Overhead Roller Track:** Manufacturer's standard carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.
1. **Rollers:** Minimum of two ball-bearing roller wheels and two anti-rise rollers for each active leaf.
- E. **Brackets and Reinforcements:** Manufacturer's standard; compatible with adjacent materials. Provide non-staining, nonferrous shims for aligning system components.
- F. **Fasteners and Accessories:** Manufacturer's standard corrosion-resistant, non-staining, non-bleeding; compatible with adjacent materials.
1. **Reinforcement:** Reinforce members as required to retain fastener threads.
 2. **Exposed Fasteners:** Do not use exposed fasteners, except for hardware application. For hardware application, use countersunk Phillips flat-head machine screws finished to match framing members or hardware being fastened, unless otherwise indicated.

2.7 HARDWARE

- A. **General:** Refer to Division 8 Section "Door Hardware" for requirements for hardware items other than those indicated to be provided by entrance door manufacturer.
- B. **Heavy-Duty Hardware:** Provide units as indicated in sizes, number, and type recommended by manufacturer for entrances required. Finish exposed parts to match door finish, unless otherwise indicated.
- C. **Emergency Breakaway Hardware:** Provide release hardware that allows panel to swing out in the direction of egress to a full 90 degrees from sliding mode as indicated. Maximum force to open panel shall be 50 lbf (222 N).
1. **Release Position:** Doors in any position.
- D. **Surface Pulls:** 1-1/2 inch diameter by 60 inch vertical stainless steel pulls on 2 inch standoffs; #4 brushed stainless steel. Confirm with manufacturer.
- E. **Compression Weather Stripping:** Manufacturer's standard replaceable, compressible

gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2287. Include bumper-type gaskets at door stops and laps.

- F. **Sweep Weather Stripping:** Manufacturer's standard replaceable weather stripping of wool, polypropylene, or nylon woven pile, with nylon-fabric or aluminum-strip backing, complying with AAMA 701. Sweep weather stripping includes stripping at jamb, head, and meeting rails where there is no stop or lap to receive compression weather stripping.

2.8 FABRICATION

- A. General: Fabricate entrance door assembly components to designs, sizes, and thicknesses specified and to comply with indicated standards.
- B. Prefabrication: Provide entrance doors as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
 - 1. Do not drill and tap for surface-mounted hardware items until time of installation at Project site.
 - 2. Perform fabrication operations, including cutting, fitting, forming, drilling, and grinding of metalwork in manner that prevents damage to exposed finish surfaces. For hardware, perform these operations before applying finishes.
 - 3. Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
 - 4. Prepare components to receive concealed fasteners and anchor and connection devices.
 - 5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
- C. Welding: Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- D. Glazing Channels: Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
- E. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- F. Hardware: Install hardware, except surface-mounted hardware, at fabrication plant. Remove only as required for final finishing operation and for delivery to and installation at Project site.
- G. Doors: Fabricate doors in profiles indicated. Reinforce as required to support imposed loads and for installing hardware. Factory assemble door and frame units.
- H. Framing: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints according to manufacturer's standards. Provide sub-frames and reinforcement of types indicated or, if not indicated, as required for a complete system to support required loads.
- I. Electrical Grounding: Fabricate entrance doors to be internally grounded, complying with requirements of authorities having jurisdiction.

2.9 ALUMINUM FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. **Clear Anodic Finish:** AAMA 611, AA-M12C22A21, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of entrance doors.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 PREPARATION
 - A. Templates and Diagrams: Furnish templates, diagrams, and other data to fabricators and installers of related work, as necessary for coordinating entrance door installation.
 - 3.3 INSTALLATION
 - A. General: Comply with entrance door manufacturer's written installation instructions, unless more stringent requirements are indicated. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure non-movement joints. Seal joints watertight.
 - B. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
 - C. Entrances: Install entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place. Lubricate operating hardware and other moving parts.
 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 2. Set tracks, header assemblies, operating brackets, and guides level and true to location with anchorage for permanent support.
 - D. Glazing: Comply with installation requirements in Division 8 Section "Glazing," unless otherwise indicated.
 - E. Sealants: Comply with requirements in Division 7 Section "Joint Sealants" for installing sealants, fillers, and gaskets.
 1. Set continuous floor tracks and flashing in a full sealant bed, unless otherwise indicated.
 2. Seal frame perimeter with sealant, unless otherwise indicated.
 - 3.4 ADJUSTING
 - A. Adjust door hardware for smooth and safe operation.
 - B. Readjust doors after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles). Lubricate hardware and other moving parts.
 - C. Test grounding system for compliance with requirements of authorities having jurisdiction.
 - 3.5 CLEANING AND PROTECTION
 - A. Clean glass and aluminum surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
 1. Comply with requirements in Division 8 Section "Glazing" for cleaning and maintaining glass.
 - B. Provide final protection and maintain conditions, including limiting construction traffic, that ensure entrance doors are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 084243

ICU ENTRANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. Section includes manually operated intensive care unit/critical care unit ICU entrances for individual special-care rooms and in Simulation labs.

1.3 SUBMITTALS

- A. **Product Data:** For each configuration of ICU entrance indicated.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. **Shop Drawings:** For each ICU entrance installation.
 - 1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
- C. **Samples for Verification:** For each type of exposed finish required, in manufacturer's standard sizes.
- D. **Sample Warranties:** For manufacturer's warranties.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An entity that employs installers and supervisors who are trained and approved by manufacturer with a minimum of **10 years' experience** installing specified products.

1.5 FIELD CONDITIONS

- A. **Field Measurements:** Verify actual dimensions of openings to receive ICU entrances by field measurements before fabrication.

1.6 WARRANTY

- A. **Special Warranty:** Manufacturer agrees to repair or replace components of ICU entrances that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Faulty operation of hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. **Warranty Period: Two years** from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. **Basis of Design:**
 - 1. Manufacturer: Horton Automatics, a division of Overhead Door Corporation.
 - 2. Product: Profiler-ICU; Type 310T.
- B. **Other Acceptable Manufacturers:** Subject to compliance with requirements, provide product by one of the manufacturers listed below:
 - 1. Besam Entrance Solutions.
 - 2. Dorma USA, Inc.

3. Stanley Access Technologies; Div. of The Stanley Works.

2.2 PERFORMANCE REQUIREMENTS

- A. **Opening Force:** Not more than 5 lbf to fully open door.

2.3 SLIDING ICU ENTRANCE ASSEMBLIES

- A. General: Provide manufacturer's standard factory-glazed ICU entrances including door leaves, sidelites, framing, headers, carrier assemblies, roller tracks, and accessories required for a complete installation as indicated.
- B. Breakaway Hardware: Release hardware that allows indicated panels to swing out in direction of egress to full 90 degrees from closed door position.
 1. Maximum Force to Open Panel: 50 lbf.
 2. Release Position: Sliding door fully open.
- C. **Sliding ICU Entrance:**
 1. **Configuration: Telescoping SO-SX-SX.**
 2. **Mounting:** Between jambs.
 3. **Floor Track Configuration:** No track across sliding-door opening and at sidelites (trackless).
 4. **Stile Design:** Medium stile; 3-1/2 inch nominal width.
 5. **Rail Design:** 5 inch nominal height.
 6. **Glazing Stops and Gaskets:** Beveled.
 7. **Glazing:** Clear tempered.

2.4 COMPONENTS

- A. **Framing Members:** Extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
 1. Nominal Size: 1-3/4 by 4-1/2 inches.
 2. Extruded Glazing Stops and Applied Trim: Minimum 0.062 inch wall thickness.
- B. **Stile and Rail Doors:** 1-3/4 inch thick glazed doors with minimum 0.125 inch thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie rods that span full length of top and bottom rails.
 1. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets for glazing indicated.
- C. **Sidelites:** 1-3/4 inch deep sidelites with minimum 0.125 inch thick, extruded-aluminum tubular stile and rail members matching door design and finish.
 1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
- D. **Glazing:** As specified in Section 088000 Glazing from full range of manufacturer's products.
- E. **Headers:** Fabricated from minimum 0.125 inch thick extruded aluminum, and extending full width of ICU entrance units to conceal carrier assemblies and roller tracks. Provide hinged or removable access panels for service and adjustment. Secure panels to prevent unauthorized access.
- F. **Carrier Assemblies and Overhead Roller Tracks:** Assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track or of ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly. Provide minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.
- G. **Brackets and Reinforcements:** High-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- H. **Fasteners and Accessories:** Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.5 HARDWARE

- A. General: Provide units in sizes and types recommended by ICU entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.
- B. **Pulls:** Recessed units on both sides of each operable door.

2.6 FABRICATION

- A. General: Factory fabricate ICU entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
 - 1. Fabricate aluminum components before finishing.
 - 2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 - 3. **Use concealed fasteners to greatest extent possible.** Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.
 - a. Where fasteners are subject to loosening or turning out from structural movements or vibration, use self-locking devices.
 - b. Reinforce members as required to receive fastener threads.
 - 4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- B. Framing: Provide ICU entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
 - 1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
 - 2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 - 3. Form profiles that are straight and free of defects or deformations.
 - 4. Provide components with concealed fasteners and anchor and connection devices.
 - 5. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
 - 6. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.
- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."
- E. Hardware: Factory install hardware to the greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.

2.7 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 2. Sheet and Plate: ASTM B 209.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Sealants and Joint Fillers: As specified in Section 079200 "Joint Sealants."

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. **Clear Anodic Finish:** AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install automatic entrances according to manufacturer's written instructions.
 - 1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
- B. Install ICU entrances plumb, true in alignment with established lines and grades, and without warp or rack of framing members and doors. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
- C. Sealants: Comply with requirements in Section 079200 "Joint Sealants" for installing sealants, fillers, and gaskets.
 - 1. Set framing members, floor tracks, and flashings in full sealant bed.
 - 2. Seal perimeter of framing members with sealant.

3.3 ADJUSTING

- A. Adjust operating hardware and moving parts to function smoothly; lubricate as recommended by manufacturer.
- B. Adjust force to open door panels.

3.4 CLEANING AND PROTECTION

- A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

END OF SECTION

SECTION 084413

GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section includes:

1. **Conventionally glazed drainable aluminum curtain walls installed as stick systems.**
2. **Reference Section 012100 Allowances for Window Testing.**

1.3 PERFORMANCE REQUIREMENTS

- A. **General:** Provide glazed aluminum curtain-wall systems, including anchorage, capable of withstanding, without failure, the effects of the following:

1. **Structural loads.**
2. **Movements of supporting structure** indicated on Drawings including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
3. **Dimensional tolerances of building frame and other adjacent construction.**
4. **Failure includes the following:**
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferred to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - d. Glass breakage.
 - e. Noise or vibration created by wind and thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Sealant failure.
 - h. **Drainage within the system allowed to deposit moisture within the exterior wall system.**
5. Ballistic resistant system and glazing.

- B. **Structural Loads:**

1. **Wind Loads: As indicated on Structural Drawings, but not less than 90 mph.**
2. Periodic Maintenance-Equipment Loads: As indicated on Drawings.

- C. **Structural-Test Performance:** Provide glazed aluminum curtain-wall systems, including anchorage, capable of withstanding test pressure indicated without material and deflection failures and permanent deformation of structural members exceeding 0.2 percent of span when tested according to ASTM E 330.

1. **Submit reports of tests** performed on manufacturer's standard assemblies.
2. **Test Pressure:** 150 percent of positive and negative wind-load design pressures.
3. **Test Duration:** As required by design wind velocity but not less than 10 seconds.

- D. **Deflection of Framing Members:**

1. **Deflection under design load shall not exceed $L/175$ for spans less than 13'-6".**
2. **Deflection under design load shall not exceed $L/240 + 1/4"$ for spans greater than 13'-6".**
3. **Cantilever Deflection:** Where framing members overhang an anchor point, limited to **2 times the length of cantilevered member, divided by 175.**

- E. **Thermal Movements:** Provide glazed aluminum curtain-wall systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface

temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. **Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.**

2. **Test Performance:** No buckling, stress on glass, glazing-edge seal failure, sealant failure, excess stress on curtain-wall framing, anchors and fasteners, or reduction of performance when tested according to AAMA 501.5.

a. Test Ambient Temperature Range: 0 to 180 deg F.

F. **Air Infiltration:** Provide glazed aluminum curtain-wall systems with **maximum air leakage of 0.06 cfm/sq. ft. of fixed wall area** when tested according to ASTM E 283 **at a minimum static-air-pressure differential of 6.24 lbf/sq. ft.**

G. **Water Penetration Under Static Pressure:** Provide aluminum glazed curtain-wall systems that do not evidence water penetration when tested according to ASTM E 331 at a **minimum differential static pressure of 20 percent of positive design wind load, but not less than 15 lbf/sq. ft.**

H. **Water Penetration Under Dynamic Pressure:** Provide glazed aluminum curtain-wall systems that do not evidence water leakage when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive design wind load, but not less than **15 lbf/sq. ft.**

1. **Maximum Water Leakage:** According to AAMA 501.1 No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

I. **Condensation Resistance:** Provide glazed aluminum curtain-wall systems with condensation-resistance factor (**CRF**) of **not less than 55** when tested according to AAMA 1503.

J. **Average Thermal Conductance:** Provide glazed aluminum curtain-wall systems with average U-factor of not more than **0.66 Btu/sq. ft. x h x deg F** when tested according to AAMA 1503.

K. **Sound Transmission:** Provide glazed aluminum curtain-wall systems with **minimum STC 32** according to ASTM E 413 **and an OITC 26** according to ASTM E 1332, as determined by testing according to ASTM E 90.

L. **Structural-Sealant Joints:**

1. Designed to carry gravity loads of glazing.

2. Designed to produce tensile or shear stress of less than 20 psi.

M. **Structural Sealant:** Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1.4 SUBMITTALS

A. **Product Data:** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

B. **Shop Drawings:** Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of glazed aluminum curtain-wall systems.

1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. **Samples for Initial Selection:** Provide one set of manufacturer's full array of standard and special finishes on actual aluminum sample panels for initial selection. Provide two 8 inch by 8 inch aluminum panels in final finish selected by Architect.

D. **Maintenance Data for Structural Sealant:** For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

E. **Qualification Data:** For Installer.

F. **Field quality-control test reports.**

G. **Warranties:** Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Capable of assuming engineering responsibility and performing Work of this Section and who is acceptable to manufacturer with a **minimum of 10 years successful experience installing specified systems.**
 - 1. **Engineering Responsibility:** Preparation of data for glazed aluminum curtain-wall systems including the following:
 - a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 - B. **Testing Agency Qualifications:** An independent agency qualified according to ASTM E 699 for testing indicated. **Also, refer to testing requirements in this section and in Section 012100, Allowances for Window Testing.**
 - C. **Product Options:** Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
 - 1. Do not modify intended **aesthetic effects, as judged solely by Architect**, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
 - D. **Welding:** Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code-Aluminum."
 - E. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to glazed aluminum curtain-wall systems including, but not limited to, the following:
 - 1. Review structural load limitations.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review required testing, inspecting, and certifying procedures.
 - F. **Testing: Refer to Allowances Section 012100 for testing allowance. Vacuum Chamber Testing shall be performed at 20% of exterior glazed units. Hose stream and other types of tests may be performed by the Owner's certified Testing Agent or the Architect with assistance by the Contractor. Testing for water infiltration will be conducted around the curtain wall system after installation of window, exterior veneer, and exterior sealant have been completed. Leave interior drywall and final finishes 4 inches clear from window rough opening until water test has been performed and results are approved by the Architect.**
 - G. **Prepare water dam test at 20% of window sills on the project. Observe for water loss through joints between windows and adjacent finishes. Leave interior side openings around entire water dam for a space of 4 inches clear for observation during testing.**
 - H. **Structural-Sealant Glazing:** Comply with ASTM C 1401 for design and installation of curtain wall assemblies.
- 1.6 PROJECT CONDITIONS
- A. **Field Measurements:** Verify actual locations of structural supports for glazed aluminum curtain-wall systems by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. **Established Dimensions:** Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating glazed aluminum curtain-wall systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.
- 1.7 WARRANTY
- A. **Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain-wall systems that do**

not comply with requirements herein or that deteriorate as defined in this Section within specified warranty period.

1. **Failures include, but are not limited to, the following:**
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals and other materials beyond normal weathering.
 - d. Water leakage.
 - e. Air leakage.
2. **Warranty Period: Five years from date of Substantial Completion.**

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 1. **EFCO Corporation.**
 2. **Arcadia Group**
 3. **Kawneer North America; an Alcoa company.**
 4. **Oldcastle Building Envelope.**

2.2 ACCEPTABLE PRODUCTS

- A. **Curtain Wall Systems:**
 1. **Typical Curtain Wall Basis of Design: EFCO 5600 Series, thermally broken as required by wind loads.** If sizes are not shown on the drawings provide 2-1/2-inch wide x 7-1/2-inch depth or as required for wind loading and structural requirements. Confirm final sizes with Architect.
 - a. **CW-1:** 2-1/2" W x 6" D.
 - b. **CW-2:** 2-1/2" W x 7-1/4" D.
 - c. **CW-3:** 2-1/2" W x 10-1/4" D.
 - d. **SGCW-1:** 2-1/2" W x 6" D.
 - e. **SGCW-2:** 2-1/2" W x 7-1/4" D.
 - f. **SGCW-3:** 2-1/2" W x 10-1/4" D.
 2. **Ribbon Wall Basis of Design: EFCO 600 RLT.**
 - a. **CWR-1:** 2-1/4" W x 6" D.
 - b. Provide hinged windows at roof access glazed panels.
 3. When designated as ballistic resistant applications, include 1/4 inch thick steel bar in the mullions.
 4. Substitutions: As approved by Architect from listed manufacturers.

2.3 FRAMING SYSTEMS

- A. **Aluminum:** Alloy and temper recommended by manufacturer for type of use and finish indicated.
 1. Sheet and Plate: ASTM B 209.
 2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 4. Welding Rods and Bare Electrodes: AWS A5.10.
- B. **Frame:**
 1. Frame components shall be mechanically fastened by means of extruded aluminum shear blocks attached to vertical mullions.
 2. Curtain wall system is able to accommodate separate interior and exterior finishes and colors.
 3. Exterior color includes scroll profile as indicated on the Drawings.
 4. Face width and system depths as indicated on the Drawings.
- C. **Steel Reinforcement:** With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment.

Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.

1. Structural Shapes, Plates, and Bars: ASTM A 36.
 2. Cold-Rolled Sheet and Strip: ASTM A 611.
 3. Hot-Rolled Sheet and Strip: ASTM A 570.
- D. **Brackets and Reinforcements:** Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.
- E. **Fasteners and Accessories:** **Manufacturer's concealed**, standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
1. **Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.**
 2. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 3. Reinforce members as required to receive fastener threads.
 4. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
- F. **Anchors:** Three-way adjustable anchors that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
- G. **Concealed Flashing:** Dead-soft, 0.018 inch thick stainless steel, ASTM A 240 of type recommended by manufacturer.
- H. **Framing Gaskets:** As recommended by manufacturer for joint type.
- I. **Framing Sealants:** As recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 8 Section "Glazing."
- B. **Glazing Gaskets:** Manufacturer's standard sealed-corner pressure-glazing system of **black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.**
- C. **Glazing Sealants for use in typical curtain wall applications:** As recommended by manufacturer for joint type.
- D. **Structural Glazing Sealants:** ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
1. **Color:** As selected by Architect from manufacturer's full range of colors.
- E. **Weatherseal Sealants:** ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
1. **Color:** Match structural sealant.

2.5 ACCESSORY MATERIALS

- A. **Shading Fins:** (Not Used).
- B. **Insulating Materials:** Specified in Division 7 Section "Building Insulation."
- C. **Flashings:** Form from sheet aluminum with same finish as extruded sections. Apply finish after fabrication. Material thickness as required to suit condition without deflection or "oil canning".
- D. **High Performance Pan Sill Flashing:** **Install manufacturer's high performance sill flashing at all windows whether or not called for on drawings.**
- E. **Wind Braces:** Manufacturer's standard wind bracing to be installed where needed to conform to performance requirements.
- F. **Bituminous Paint:** Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

2.6 FABRICATION

- A. Form aluminum shapes before finishing.
- B. **Construction: Thermally broken.**
- C. **Fabricate components that, when assembled, have the following characteristics:**
 - 1. Sharp profiles, straight and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. **Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.**
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to prevent glazing-to-glazing contact and to maintain required glazing edge clearances.
 - 6. **Provisions for re-glazing from exterior.**
- D. **Fabricate with drainage system directing all moisture to the exterior of the system and wall. Allow for no water to deposit in the wall system or cavity.**
- E. **Weld in concealed locations to greatest extent possible** to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- G. **Fabricate Members with welded "end dams" at the sill and other locations as required to collect and direct water to the exterior of the system.**
- H. **Double vertical mullions are not permitted. Splayed mullions only allowed with Architect's specific permission. Splayed mullions, if approved, shall have flat exterior trim cap unless otherwise specifically approved by the Architect.**
- I. **At curved or segmented glazed areas (if any), provide splayed millions (with Architect's approval) as required to accommodate radius required without double mullions.**

2.7 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. ~~**Mica-Metallic High-Performance Organic Finish:** Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.~~
 - 1. ~~**Color:** Refer to Document 008900 - Finish Selection Summary.~~
- D. **Clear Anodic Finish:** AAMA 611, AA-M12C22A21, Class I, 0.018 mm or thicker.
- E. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.8 SOURCE QUALITY CONTROL

- A. **Structural Sealant:** Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:

- 1. Comply with manufacturer's written instructions.
- 2. Do not install damaged components.
- 3. Fit joints to produce hairline joints free of burrs and distortion.
- 4. Rigidly secure non-movement joints.
- 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- 6. Seal joints watertight, unless otherwise indicated.
- 7. **Use only concealed fasteners. Any curtainwall installed with exposed fasteners shall be removed and replaced at the contractor's expense.**

B. Metal Protection:

- 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
- 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. **Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to the exterior.**

D. Install components plumb and true in alignment with established lines and grades.

E. **Install manufacturer's high performance pan sill flashing at all locations. Provide welded end dams and ensure water is directed to the exterior of the system.**

F. Coordinate attachment and seal of air and vapor barrier materials.

G. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

H. Install glazing as specified Division 8 Section "Glazing."

- 1. **Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.**

I. Install sealants as specified in Division 7 Section "Joint Sealants."

- 1. **Where installing aluminum window systems adjacent to rough surfaces clean and force float sealant into rough surface. Allow sealant to set per manufacturer's recommendations, then install aluminum window system and seal between aluminum window systems and smooth sealant surface.**

J. Install insulation materials as specified in Division 7 Section "Building Insulation."

K. **Erection Tolerances:** Install glazed aluminum curtain-wall systems to comply with the following maximum tolerances:

- 1. **Plumb:** 1/8 inch in 10 feet; 1/4 inch in 40 feet.
- 2. **Level:** 1/8 inch in 20 feet; 1/4 inch in 40 feet.
- 3. **Alignment:**
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or greater, limit offset from true alignment to 1/4 inch.
- 4. **Location:** Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.4 FIELD QUALITY CONTROL

- A. **Testing Agency:** Notify and coordinate with Owner's independent testing agency or Architect to water test in-place system. **Refer to Section 012100 Allowances for Window Testing.**

1. **Test a minimum of 20 percent of the windows on the project utilizing vacuum chamber testing method by a certified window testing consultant. Additional hose stream testing may be performed by the Architect with the assistance of the Contractor.**
2. **Test 20 percent of the end dam installations on the project.**
- B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
- C. Additional testing and inspection, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- D. **Structural-Sealant Adhesion:** Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
 1. Test a minimum of four areas on each building facade.
 2. Repair installation areas damaged by testing.
- E. **Require manufacturer to inspect the project three times during the installation of system to include:**
 1. Review of substrate prior to installation to ensure acceptance.
 2. During course of system installation.
 3. At final completion of system installation.
 4. **Provide written report of inspection to Architect within three days of inspections as a prerequisite for Contractor's Application for Payment that month.**

END OF SECTION

SECTION 084511

TRANSLUCENT LINEAR CHANNEL GLAZING SYSTEM

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Sections includes: Translucent linear glass units, framing, glazing accessories.
- 1.2 SUBMITTALS
 - A. **Product Data:** Submit manufacturer's technical literature. Include manufacturer's product data providing product descriptions, technical data, and installation instructions
 - B. **Shop Drawings:** Include plans, elevations, and details of product showing component dimensions.
 - C. **Samples for Verification:** Standard sample length by full panel width in size.
 - D. **Warranties:** Submit manufacturer's warranty.
- 1.3 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver materials to specified destination in manufacturer or distributor packaging, undamaged, complete with installation instructions.
 - B. Store off ground, on a level surface, under cover, and protected from weather and construction activities in accordance with manufacturer's recommendations.
- 1.4 WARRANTY
 - A. **Material Warranty:** Provide manufacturer's limited **10-year warranty**.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS AND PRODUCTS
 - A. **Basis of Design:**
 - 1. **Manufacturer:** Pilkington Profilit™ channel glass system, supplied by Technical Glass Products.
 - 2. **Product:** As indicated in Section 008900 - Finish Selection Summary.
- 2.2 PERFORMANCE
 - A. **System Description:** Thermally Broken aluminum frame with double glazed, translucent, linear glass with 2-3/8 inch deep channel flange.
 - B. **Air Infiltration Requirements:** ASTM E 283 at 6.24 PSF. Total amount of air infiltration shall not exceed 0.06 cubic foot/minute square foot of wall area tested.
 - C. **Water Penetration Under Static Pressure:** In accordance with ASTM E 331-00; air pressure 20 percent design wind load; 6.24 PSF minimum, 20 PSF maximum, applied against face. No uncontrolled water penetration allowed
 - D. **Structural Requirements:** AAMA/NWWDA/CSA 101/1.S.21 A440-08 and ASTM F 588.
 - E. **Glazing Requirements:** 16 CFR 1201, Category I and Category II.
- 2.3 MATERIALS
 - A. **Glass:** ASTM C1036, Type 1, Class 1, Quality q3, rolled glass, channel shape, cast.
 - 1. Nominal thickness of 0.120 inch for framing members and rails, 0.090 inch for sheets, and 0.050 inch for glazing stops and similar components
 - B. **Stainless Steel Wire:** ASTM A492, Type 316.
 - C. **Aluminum:** ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 5005-H16 for sheets; or other alloys and temper recommended by manufacturer appropriate for specified finish.
 - D. **Vinyl:** AAMA 303 external grade unplasticized PVC.

2.4 ACCESSORIES

- A. Anchorage Devices: Manufacturer's standard formed or fabricated steel or aluminum assemblies or shapes, plates, bars or tubes.
- B. Fasteners: Aluminum, non-magnetic stainless steel or other non-corrosive materials compatible with items being fastened.
 - 1. Provide concealed fasteners wherever possible.
 - 2. Exposed Locations: Phillips flathead screws with finish matching item fastened.
 - 3. Concealed Locations: Manufacturer's recommended standard fasteners.
- C. Expansion Anchor Devices: Lead-shield or toothed-steel, drilled-in, expansion bolt anchors.
- D. Perimeter Joint Sealant and Backer Rod: Silicone-Glazing.
 - 1. Colors: Standard colors as selected by Architect from manufacturer's full range of colors.
 - 2. Primer: If required by sealant manufacturer for applications show.
 - 3. Sealant Backing, Bond Breaker Rod and Tape: Closed cell unless required by sealant manufacturer.

2.5 FABRICATION

- A. Coordination of Fabrication: Check actual frame or door openings required in construction work by accurate field measurements before fabrication.
 - 1. Fabricate units to withstand design loads that will be applied when system is in place.
- B. General: Provide each unit of framework continuous.
 - 1. Disassemble only to extent necessary for shipment and installation.
 - 2. Conceal fasteners wherever possible.
 - 3. Form gutter and weep system to prevent water infiltration.
 - 4. Separate dissimilar metals and aluminum in contact with concrete utilizing protective coating or preformed separators, which will prevent contact and corrosion.
- C. Aluminum Framing: Provide members of size, shape and profile indicated, designed to provide for glazing from exterior or interior.
 - 1. Provide manufacturer's standard thermal isolation between exterior and interior aluminum extrusions.
 - 2. Fabricate frame assemblies with mitered or coped joints.
 - 3. Maintain accurate relation of planes and angles, with hairline fit or contacting members.
 - 4. Seal horizontals and direct moisture accumulation to exterior.
 - 5. Provide spacers and other materials used internally or externally that are corrosive resistant, non-staining, non-bleeding and compatible with adjoining materials.
 - 6. Fabricate framing for expansion and contraction due to temperature changes without detriment to appearance or performance.
 - 7. Make provisions in framing for minimum edge clearance, nominal edge cover and nominal pocket width for thickness and type of glazing or infill used in accordance with recommendations of manufacturer and Technical Manual.
- D. Welding: Comply with recommendations of American Welding Society (AWS).
 - 1. Use recommended electrodes and methods to avoid distortion and discoloration.
 - 2. Grind exposed welds smooth and flush with adjacent surfaces; restore mechanical finish.

2.6 ALUMINUM FINISH

- A. **Fluorocarbon Coating:** AAMA 2605. Match color on curtain wall.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting framing, with installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
 - 2. Minimum required face or edge clearances.
 - 3. Observable edge damage or face imperfections.
- B. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 **INSTALLATION**

- A. Install units in accordance with manufacturer's written instructions, plumb, level, square, and free from warp or twist while maintaining dimensional tolerances and alignment with surrounding construction.
- B. Erect framing, vinyl spacer, and glass in accordance with manufacturer's printed installation instructions. Seal glass units continuously on both sides of glass between frame and glass and between linear glass units.
- C. Joint Sealant: Install perimeter joint sealant and backing materials between assemblies and adjacent construction.
- D. **Erection Tolerances:**
 - 1. Limit Variations from Plumb and Level:
 - a. 1/8 inch in 10 feet vertically.
 - b. 1/8 inch in 20 feet horizontally.
 - 2. Limit Variations from Theoretical Locations: 1/4 inch for any member at any location.
 - 3. Limit Offsets in Theoretical End-To-End and Edge-To-Edge Alignment: 1/16 inch from flush surfaces not more than 2 inches apart or out-of-flush by more than 1/4 inch.

END OF SECTION

SECTION 087100

DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Door Hardware Schedule".
 - 2. Division 08 Section "Hollow Metal Doors and Frames".
 - 3. Division 08 Section "Flush Wood Doors".
 - 4. Division 08 Section "Access Control Hardware".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards:
 - 1. ANSI/BHMA Certified Product Standards - A156 Series
 - 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 - 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 - 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 - 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
 - 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

- F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Twenty five years for manual surface door closer bodies.
 - 3. Ten years for heavy duty floor closers.
 - 4. Two years for shallow depth floor closers.
 - 5. Five years for motorized electric latch retraction exit devices.
 - 6. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
- C. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- D. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
 - 1. Quantity: Provide the following hinge quantity, unless otherwise indicated:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 - 4. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:

- a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Acceptable Manufacturers:

- a. Hager Companies (HA).
- b. McKinney Products (MK).

- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Acceptable Manufacturers:

- a. Hager Companies (HA).
- b. Pemko Manufacturing (PE).

- C. Floor Closers: ANSI/BHMA A156.4 certified floor closers. Provide independent and adjustable valves for closing speed, latch speed, and backcheck with built-in dead stop and hold open features as specified. Provide finished cover plates or thresholds as indicated in door Hardware Sets.

1. Acceptable Manufacturers:

- a. Rixson Door Controls (RF).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Acceptable Manufacturers:

- a. McKinney Products (MK) - QC (# wires) Option.

- B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a 12" removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Acceptable Manufacturers:

- a. McKinney Products (MK) - SER-QC (# wires) Option.
 - b. Pemko Manufacturing (PE) - SER-QC (# wires) Option.
- C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
 - 1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products (MK) - Connector Hand Tool: QC-R003.
 - 2. Acceptable Manufacturers:
 - a. McKinney Products (MK) – QC-C Series.

2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
 - 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 - 2. Furnish dust proof strikes for bottom bolts.
 - 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 - 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 - 5. Acceptable Manufacturers:
 - a. Rockwood Manufacturing (RO).
 - b. Trimco (TC).
- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
 - 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 - 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
 - 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 - 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - 5. Acceptable Manufacturers:

- a. Rockwood Manufacturing (RO).
- b. Trimco (TC).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinders: Original manufacturer cylinders complying with the following:
 - 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 - 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 - 4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 5. Keyway: Match Facility Restricted Keyway.
- D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
 - 2. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware. Provide removable core (small or large format) as specified in Hardware Sets.
- E. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. Existing System: Key locks to Owner's existing system.
- F. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Two (2)
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
- G. Construction Keying: Provide temporary keyed construction cores.
- H. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
 - 1. Acceptable Manufacturers:

- a. Lund Equipment (LU).
- b. MMF Industries (MM).
- c. Telkee (TK).

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

- 1. Acceptable Manufacturers:

- a. Corbin Russwin Hardware (RU) – ML2000 Series.
 - b. No Substitution.

- B. Narrow Stile Interconnected Locksets:

- 1. Interconnected locksets designed with a mortise case which contains both a latchbolt and deadbolt and allows simultaneous retraction of both the latchbolt and deadbolt with a single motion turning of the lever handle.
- 2. Locksets to be non-handed and available with a 1 1/8" or 1 1/2" standard backset.
- 3. Latchbolt and deadbolt shall be fabricated of wrought brass and bronze with a minimum 3/4" latchbolt throw and 1" deadbolt throw.
- 4. Acceptable Manufacturers:
 - a. Adams Rite (AD) – 2190/2290 Series.

2.7 ELECTROMECHANICAL LOCKING DEVICES

- A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.

- 1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
- 2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
- 3. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML20900 Series.
 - b. No Substitution.

2.8 AUXILIARY LOCKS

- A. Push-Pull Latches, Paddle Type, Mortise: ANSI/BHMA A156.13, Series 1000, Operational and Security Grade 1 mortise type push-pull locks and latches with ligature-resistant paddle trim capable of being mounted in vertical (up or down) and horizontal (sideways) positions. Locksets to be manufactured with a corrosion resistant, formed steel case and be non-handed, field-reversible for re-handing without disassembly of the lock body. Paddles and covers are manufactured from cast stainless steel or brass material. Provide optional lead-lining (lock body) and Torx® fasteners as specified in Hardware Sets.
 - 1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 HPSK Series.

2.9 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 - 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 - 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 - 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 - 4. Dustproof Strikes: BHMA A156.16.

2.10 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
 - 1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
 - 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 5. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Acceptable Manufacturers:
 - a. Von Duprin (VD) - 35A/98 XP Series.

2.11 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
 4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
 5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC8000 Series.
 - b. No Substitution.
- C. Door Closers, Surface Mounted (Commercial Duty): ANSI/BHMA 156.4, Grade 1 certified surface mounted, institutional grade door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck, closing sweep, and latch speed control valves. Provide non-handed units standard.
1. Acceptable Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC6000 Series.
 - b. No Substitution.

2.12 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

2. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
3. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
4. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
5. Acceptable Manufacturers:
 - a. Rockwood Manufacturing (RO).

2.13 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Acceptable Manufacturers:
 - a. Rockwood Manufacturing (RO).
 - b. Trimco (TC).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
 1. Acceptable Manufacturers:
 - a. Rixson Door Controls (RF).
 - b. Rockwood Manufacturing (RO).
 - c. Sargent Manufacturing (SA).

2.14 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Acceptable Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Manufacturing (PE).
 - 3. Reese Enterprises, Inc. (RE).

2.15 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.16 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

1. MK - McKinney
2. PE - Pemko
3. RF - Rixson
4. RO - Rockwood
5. RU - Corbin Russwin
6. AD - Adams Rite
7. VD - Von Duprin
8. HS - HES
9. NO - Norton
10. OT - OTHER
11. RI - RITE Door

Hardware Sets

Set: 1.01

Doors: 1VEST3B

2 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	↗
1 Rim Exit Device	QEL RX 98EO	US32D	VD	
1 Rim Exit Device	QEL RX 98NL-OP 110MD-NL	US32D	VD	
2 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Cylinder	1080-114- CT6R	626	RU	
1 Cylinder	3080-178- CT6R	626	RU	
2 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO	
2 Closer (surface)	DC8210 A11	689	RU	
1 Threshold	171A		PE	
2 Sweep	315CN		PE	
2 Wire Harness	CON-12P		VD	
2 Wire Harness	CON-192P		VD	
1 Drop Plate	754F25		RU	
2 Contact Switch	Furnished by Security Contractor		00	
1 Card Reader	Furnished by security Contractor		RU	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOORS ON SCHEDULE THROUGH ACS.
 AUTHORIZED CARD PRESENTED AT READER RETRACTS LATCHBOLT FOR VALID ENTRY.
 FREE EGRESS AT ALL TIMES.
 REQUEST TO EXIT SWITCH IN TOUCHRAIL SHUNTS ALARM.
 FAIL SECURE.
 KEY RETRACTS LATCHBOLT

Set: 1.01.SE

Doors: 1LOBB2A, 1VEST1A, 1VEST2A

2 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	✂
1 Rim Exit Device	QEL RX 98EO	US32D	VD	
1 Rim Exit Device	QEL RX 98NL-OP 110MD-NL	US32D	VD	
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Cylinder	1080-114- CT6R	626	RU	
1 Cylinder	3080-178- CT6R	626	RU	
2 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO	
2 Door Operator (smoke evac system)	6330 as required	600	NO	✂
1 Threshold	171A		PE	
2 Sweep	315CN		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Contact Switch	Furnished by Security Contractor		00	
1 Card Reader	Furnished by security Contractor		RU	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOORS ON SCHEDULE THROUGH ACS.
 AUTHORIZED CARD PRESENTED AT READER RETRACTS LATCHBOLT FOR VALID ENTRY.
 FREE EGRESS AT ALL TIMES.
 REQUEST TO EXIT SWITCH IN TOUCHRAIL SHUNTS ALARM.
 FAIL SECURE.
 KEY RETRACTS LATCHBOLT.
 SMOKE EVAC SYSTEM.

Set: 1.01A.SE

Doors: 1LOBB2B

1 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	✂
1 Rim Exit Device	QEL RX 98EO	US32D	VD	
1 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO	
1 Door Operator (smoke evac system)	6330 as required	600	NO	✂
1 Threshold	171A		PE	
1 Sweep	315CN		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Contact Switch	Furnished by Security Contractor		00	
1 Card Reader	Furnished by security Contractor		RU	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOORS ON SCHEDULE THROUGH ACS.
 AUTHORIZED CARD PRESENTED AT READER RETRACTS LATCHBOLT FOR VALID ENTRY.
 FREE EGRESS AT ALL TIMES.
 REQUEST TO EXIT SWITCH IN TOUCHRAIL SHUNTS ALARM.
 FAIL SECURE.
 SMOKE EVAC SYSTEM.

Set: 1.01B.SE

1 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	✂
1 Rim Exit Device	QEL RX 98NL-OP 110MD-NL	US32D	VD	
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Cylinder	1080-114- CT6R	626	RU	
1 Cylinder	3080-178- CT6R	626	RU	
1 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO	
1 Door Operator (smoke evac system)	6330 as required	600	NO	✂
1 Threshold	171A		PE	
1 Sweep	315CN		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Drop Plate	754F25		RU	
1 Contact Switch	Furnished by Security Contractor		00	
1 Card Reader	Furnished by security Contractor		RU	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOORS ON SCHEDULE THROUGH ACS.
AUTHORIZED CARD PRESENTED AT READER RETRACTS LATCHBOLT FOR VALID ENTRY.
FREE EGRESS AT ALL TIMES.
REQUEST TO EXIT SWITCH IN TOUCHRAIL SHUNTS ALARM.
FAIL SECURE.
KEY RETRACTS LATCHBOLT.
SMOKE EVAC SYSTEM.

Set: 1.01C.SE

Doors: 1LOBB2C

1 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	✂
1 Rim Exit Device	QEL RX 98EO	US32D	VD	
1 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO	
1 Door Operator (smoke evac system)	6330 as required	600	NO	✂
1 Threshold	171A		PE	
1 Sweep	315CN		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Contact Switch	Furnished by Security Contractor		00	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOORS ON SCHEDULE THROUGH ACS.
FREE EGRESS AT ALL TIMES.
REQUEST TO EXIT SWITCH IN TOUCHRAIL SHUNTS ALARM.
FAIL SECURE.

SMOKE EVAC SYSTEM.

Set: 1.02

Doors: 101B

1 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	↗
1 Rim Exit Device	RX 98L LAT E 996L(Std)	US32D	VD	
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Cylinder	3080-178- CT6R	626	RU	
1 Closer (surface)	DC6210 A11	689	RU	
1 Threshold	171A		PE	
1 Sweep	315CN		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Drop Plate	754F25		RU	
1 Contact Switch	Furnished by Security Contractor		00	
1 Card Reader	Furnished by security Contractor		RU	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOOR NORMALLY LOCKED AND SECURED
 AUTHORIZED CARD PRESENTED AT READER UNLOCKS TRIM
 FREE EGRESS AT ALL TIMES.
 REQUEST TO EXIT SWITCH IN LOCKSET SHUNTS ALARM.
 FAIL SECURE

Set: 1.03

Doors: 1CORR6B

1 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	↗
1 Rim Exit Device	RX 98L LAT E 996L(Std)	US32D	VD	
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Cylinder	3080-178- CT6R	626	RU	
1 Closer (surface)	DC6210 A11	689	RU	
1 Threshold	171A		PE	
1 Gasketing	332CS		PE	
1 Rain Guard	346C		PE	
1 Sweep	315CN		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Drop Plate	754F25		RU	
1 Contact Switch	Furnished by Security Contractor		00	
1 Card Reader	Furnished by security Contractor		RU	
1 Power Supply	Furnished by security Contractor		00	

Notes: DOOR NORMALLY LOCKED AND SECURED

AUTHORIZED CARD PRESENTED AT READER UNLOCKS TRIM
 FREE EGRESS AT ALL TIMES.
 REQUEST TO EXIT SWITCH IN LOCKSET SHUNTS ALARM.
 FAIL SECURE

Set: 1.03.N

Doors: 1ELEC1B, 1MECH1, 1STRW1B, 1STRW2B, 1STRW3

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Rim Exit Device	98L LAT 996L(Std)	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A11	689	RU
1 Threshold	171A		PE
1 Gasketing	332CS		PE
1 Rain Guard	346C		PE
1 Sweep	315CN		PE
1 Drop Plate	754F25		RU

Notes: DOOR NORMALLY LOCKED AND SECURED
 FREE EGRESS AT ALL TIMES.

Set: 1.04

Doors: 1CORR3, 1STRW1A

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Hinge	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK ✕
1 Rim Exit Device	RX 98L LAT E 996L(Std)	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO
1 Wire Harness	CON-12P		VD
1 Wire Harness	CON-192P		VD
1 Contact Switch	Furnished by Security Contractor		00
1 Card Reader	Furnished by security Contractor		RU
1 Power Supply	Furnished by security Contractor		00

Notes: DOOR NORMALLY LOCKED AND SECURED
 AUTHORIZED CARD PRESENTED AT READER UNLOCKS TRIM
 FREE EGRESS AT ALL TIMES.
 REQUEST TO EXIT SWITCH IN LOCKSET SHUNTS ALARM.
 FAIL SECURE

Set: 1.05

Doors: 120

4 Hinge	TA2714 4-1/2" x 4-1/2" NRP	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO
1 Sound Seal	S773BL		PE
1 Sound Seal	S44BL		PE
1 Sound Door Bottom	PDB411AE		PE
1 Sound Threshold	2008STCxQ380A		PE

Set: 1.06

Doors: 241

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Hinge	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK ✗
1 Electrified Mortise Lock (fail secure, signal switch)	ML20906-SEC 102X M92 C6 CT6R	626	RU ✗
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO
3 Silencer	608-RKW		RO
1 ElectroLynx Harness	QC-C1500P		MK ✗
1 ElectroLynx Harness	QC-C300P		MK ✗
1 Contact Switch	Furnished by Security Contractor	00	
1 Card Reader	Furnished by security Contractor	RU	
1 Power Supply	Furnished by security Contractor	00	

Notes: DOOR NORMALLY CLOSED AND SECURED
AUTHORIZED CARD PRESENTED AT READER UNLOCKS LEVER TRIM
FREE EGRESS AT ALL TIMES,
REQUEST TO EXIT SWITCH IN LOCKSET SHUNTS ALARM
FAIL SECURE

Set: 1.06.N

Doors: 1COMM1, 204, 2COMM1, 2COMM2, 3COMM1, 4COMM1

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
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1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO
3 Silencer	608-RKW		RO

Set: 1.07

Doors: 1ELEC2, 2ELEC1, 3ELEC1, 4ELEC1

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO
3 Silencer	608-RKW		RO

Set: 1.08

Doors: 104

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Hinge	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK ✗
1 Electrified Mortise Lock (fail safe, signal switch)	ML20932-SAF 102X M92 CT6R	626	RU ✗
2 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO
3 Silencer	608-RKW		RO
1 ElectroLynx Harness	QC-C1500P		MK ✗
1 ElectroLynx Harness	QC-C300P		MK ✗
1 Contact Switch	Furnished by Security Contractor		00
2 Card Reader	Furnished by security Contractor		RU
1 Power Supply	Furnished by security Contractor		00

Notes: DOOR NORMALLY LOCKED AND SECURED.
 AUTHORIZED CARD PRESENTED AT READER EITHER SIDE UNLOCKS LEVER TRIM,
 FAIL SAFE -

Set: 1.09

Doors: 1STRW2A

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU

1 Wall Stop	406	US26D	RO
1 Gasketing	S773D		PE

Set: 1.10

Doors: 142, 1COMP, 1FIRE1A, 5STRW2B

1 Continuous Hinge	CFM__SLF-HD1 QC12 SER12		PE	✂
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU	
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Closer (surface)	DC6210 A4 M54	689	RU	
1 Threshold	171A		PE	
1 Gasketing	332CS		PE	
1 Rain Guard	346C		PE	
1 Sweep	315CN		PE	
1 Contact Switch	Furnished by Security Contractor		00	

Notes: DOOR CONTACT SWITCH ONLY TO MONITOR DOOR STATUS.

Set: 1.13

Doors: 201

1 Continuous Hinge	CFM__SLF-HD1		PE	
1 Fire Rated Rim Exit	98L-F LAT 996L(Std)	US32D	VD	
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Cylinder	3080-178- CT6R	626	RU	
1 Closer (surface)	DC6210 A3 M54	689	RU	
1 Wall Stop	406	US26D	RO	
1 Gasketing	S773D		PE	

Set: 1.14

Doors: 2STRW1

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK	
1 Hinge	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK	✂
1 Fire Rated Rim Exit	RX 98L-BE-F LAT 996L-BE	US32D	VD	
1 Closer (surface)	DC6200	689	RU	
1 Wall Stop	406	US26D	RO	
1 Gasketing	S773D		PE	
1 Wire Harness	CON-12P		VD	
1 Wire Harness	CON-192P		VD	
1 Contact Switch	Furnished by Security Contractor		00	

Notes: DOOR CONTACT SWITCH ONLY TO MONITOR DOOR STATUS
REQUEST TO EXIT SWITCH IN TOUCH RAIL SHUNTS ALARM.

Set: 1.15

Doors: 2STRW3

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Hinge	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK ✕
1 Fire Rated Rim Exit	RX 98L-F LAT E 996L(Std)	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO
1 Gasketing	S773D		PE
1 Wire Harness	CON-12P		VD
1 Wire Harness	CON-192P		VD
1 Contact Switch	Furnished by Security Contractor	00	
1 Power Supply	Furnished by security Contractor	00	

Notes: DOOR NORMALLY LOCKED AND SECURED
FREE EGRESS AT ALL TIMES.
REQUEST TO EXIT SWITCH IN LOCKSET SHUNTS ALARM.
FAIL SAFE, INTEGRATED WITH SMOKE/FIRE ALARM SYSTEM.

Set: 1.16

3 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU

Set: 1.17

Doors: 330

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Mortise Lockset (security entrance/classroom lock, ADA thumb turn)	ML2075 102X M34 C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6210 A4 M54	689	RU

Set: 2.01

Doors: 1VEST3A

2 Continuous Hinge	CFM__SLF-HD1		PE
2 Push Bar	RM3112 Mtg-Type 12XHD x width as required	US32D	RO

2 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO
2 Closer (surface)	DC8210 A11	689	RU
2 Drop Plate	754F25		RU

Notes: Security locks/unlocks deadbolt.

Set: 2.01.SE

Doors: 1VEST1B, 1VEST2B

2 Continuous Hinge	CFM__SLF-HD1		PE
2 Push Bar	RM3112 Mtg-Type 12XHD x width as required	US32D	RO
2 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO
2 Door Operator (smoke evac system)	6330 as required	600	NO ✗

Notes: SMOKE EVAC SYSTEM.

Set: 2.02.SE

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Push Bar	RM3112 Mtg-Type 12XHD x width as required	US32D	RO
1 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO
1 Door Operator (smoke evac system)	6330 as required	600	NO ✗

Notes: SMOKE EVAC SYSTEM.

Set: 2.03

Doors: 1LOBB2D

2 Continuous Hinge	CFM__SLF-HD1		PE
1 Manual Flush Bolt	555	US26D	RO
1 Flush Bolt	555-24	US26D	RO
1 Mortise Deadlock (al/gl dr)	1850S x as required	628	AD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	1080-114- CT6R	626	RU
2 Push Bar	RM3112 Mtg-Type 12XHD x width as required	US32D	RO
2 Semi-Circular Pull	RM4506 Mtg-Type 12XHD	US32D	RO
2 Closer (surface)	DC8210 A11	689	RU
1 Drop Plate	754F25		RU

Notes: Security locks/unlocks deadbolt.

Set: 3.01

Doors: 106, 1CORR1, 1MECH2B, 201A, 201B, 201C, 201D, 201E, 201F, 201G, 201H, 255A, 255B, 255C, 255D, 256A, 2CORR1A, 2CORR1B, 3CORR1A, N/A - 9027374

1 Specialty Door Assembly	All hardware by assembly manufacturer (non-keyed)	00
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Set: 3.02

Doors: 146E, 146F, 206, 256B, 260B, 353

1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	1080-114- CT6R	626	RU
1 Barn Door Assembly	All hardware by barn door manufacturer		OT

Notes: CONFIRM ANY KEYED CYLINDER REQUIREMENTS.

Set: 4.01

Doors: 121A, 121B, 122, 123, 124A, 125, 126, 127, 128, 129, 131, 210A, 210B, 210C, 210D, 210E, 210F, 330A, 330B, 330C, 412A, 412B, 413, 415, 420A, 420B, 420C, 420D, 420E, 420F, 420G, 420H, 420J, 422, 430A, 430B, 430C, 430D, 430E, 430F, 430G, 430H, 430J, 430K, 430L, 430M, 430N, 430P, 430Q, 430R, 430S, 430T, 440A, 440AA, 440AB, 440AC, 440B, 440C, 440D, 440E, 440F, 440G, 440H, 440J, 440K, 440L, 440M, 440N, 440P, 440Q, 440R, 440S, 440T, 440V, 440W, 440X, 440Y, 440Z, 446, 450A, 450B, 450C, 450D, 450E, 450F, 453, 454, 455

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (entrance/office, ADA thumb turn)	ML2054 102X M34 C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Wall Stop	406	US26D	RO

Set: 4.02

Doors: 305, 306

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (entrance/office, ADA thumb turn)	ML2054 102X M34 C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO

Set: 5.01

Doors: 106B, 410, 420, 424A, 426, 440, 450

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (security entrance/classroom lock, ADA)	ML2075 102X M34 C6	626	RU

thumb turn)				
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Closer (surface)	DC6210 A3 M54	689	RU	
1 Wall Stop	406	US26D	RO	

Set: 5.03

Doors: 143, 145, 202, 240, 261, 307

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK	
Mortise Lockset (security				
1 entrance/classroom lock, ADA	ML2075 102X M34 C6	626	RU	
thumb turn)				
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Closer (surface)	DC6200	689	RU	
1 Wall Stop	406	US26D	RO	

Set: 5.04

Doors: 207, 302, 303, 304, 430

1 Continuous Hinge	CFM__SLF-HD1		PE	
Mortise Lockset (security				
1 entrance/classroom lock, ADA	ML2075 102X M34 C6	626	RU	
thumb turn)				
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Closer (surface)	DC6200	689	RU	
1 Wall Stop	406	US26D	RO	

Set: 5.05

Doors: 352

4 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	
Mortise Lockset (security				
1 entrance/classroom lock, ADA	ML2075 102X M34 C6	626	RU	
thumb turn)				
1 Interchangeable Core	8000 (N Keyway)	626	RU	
1 Closer (surface)	DC6200	689	RU	
1 Wall Stop	406	US26D	RO	

Set: 5.06

Doors: 132

4 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	
Mortise Lockset (security				
1 entrance/classroom lock, ADA	ML2075 102X M34 C6	626	RU	
thumb turn)				

1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Surface Overhead Stop	10-X36	630	RF
1 Closer (surface)	DC6200	689	RU

Set: 6.01

Doors: 124B, 141, 261A, 414, 416, 431, 452

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lock (passage)	ML2010 102X	626	RU
1 Wall Stop	406	US26D	RO

Set: 6.02

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lock (passage)	ML2010 102X	626	RU
1 Surface Overhead Stop	10-X36	630	RF

Set: 6.03

Doors: 231, 232, 233, 234, 235

1 Pivot Set	L147x L180	626	RF
1 Intermediate Pivot	ML19	626	RF
1 Mortise Lockset (passage, lead lined)	ML2010 102X M29	626	RU
1 Surface Closer (lead lined cover)	DC8200 M73 M108	689	RU
1 Heavy Duty Floor Stop	463	US32D	RO

Notes: Lead lined assembly.

Set: 6.04

Doors: 1CORR6A, 433, 451

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lock (passage)	ML2010 102X	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO

Set: 7.01

Doors: 103C, 110, 1CUST1, 2CUST1, 303A, 332, 362, 3CUST1, 418, 434, 436B, 440U, 448, 4CUST1

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Wall Stop	406	US26D	RO

Set: 7.02

Doors: 101C, 102, 236, 252, 253, 351B

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO

Set: 7.03

Doors: 251, 432, 435

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO

Set: 7.04

Doors: 351A

4 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO

Set: 7.05

Doors: 363

8 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Manual Flush Bolt	555	US26D	RO
1 Flush Bolt	555-24	US26D	RO
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
2 Wall Stop	406	US26D	RO

Set: 7.06

Doors: 5STRW2A

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (storeroom)	ML2057 102X C6	626	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Wall Stop	406	US26D	RO
1 Gasketing	S88BL 17"		PE

Set: 8.01

Doors: 1MRR1, 1WRR1, 1WRR2, 2MRR1, 2WRR1, 3MRR1, 3WRR1, 4MRR1, 4WRR1

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Push Plate	70E	US32D	RO
1 Pull Plate	107x70C	US32D	RO
1 Closer (surface)	DC6200	689	RU
1 Kick Plate	K1050 10" X 2" LDW	US32D	RO
1 Wall Stop	406	US26D	RO

Set: 8.02

Doors: 146A

2 Floor Closer	PH 5023NBC	626	RF
4 Push Plate	70E	US32D	RO
4 Heavy Duty Floor Stop	463	US32D	RO

Set: 9.02

Doors: 1MRR2, 1URR1, 1URR2

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Mortise Lockset (privacy, occupancy indicator, ADA thumb turn)	ML2030 102X M34 M19V	626	RU
1 Closer (surface)	DC6200	689	RU
1 Kick Plate	K1050 10" X 2" LDW	US32D	RO
1 Wall Stop	406	US26D	RO

Set: 10.01

Doors: 260A

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Mortise Lockset (paddle trim, security entrance/classroom lock, ADA thumb turn)	ML2075 HPSK M34 C6	630	RU
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Closer (surface)	DC6200	689	RU
1 Armor Plate	K1050 34 X 2" LDW	US32D	RO
1 Wall Stop	406	US26D	RO

Set: 11.01

Doors: 103A, 103B, 146B, 146D, 1ELEC1A, 310A, 310B, 340A, 340B

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Rim Exit Device	98L LAT 996L(Std)	US32D	VD

1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO

Set: 11.02

Doors: 101A, 101D, 250, 2CORR2, 2STRW2, 3CORR2, 4CORR6A, 4CORR6B

4 Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Fire Rated Rim Exit	98L-F LAT 996L(Std)	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO

Set: 11.03

Doors: 230, 2CORR3B, 350, 360, 3STRW3, 4STRW1, 4STRW3

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Rim Exit Device	98L LAT 996L(Std)	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO

Set: 11.04

Doors: 3STRW1, 3STRW2, 4STRW2

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Fire Rated Rim Exit	98L-BE-F LAT 996L-BE	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO

Set: 11.05

Doors: 2CORR4

1 Continuous Hinge	CFM__SLF-HD1		PE
1 Rim Exit Device	98L LAT 996L(Std)	US32D	VD
1 Interchangeable Core	8000 (N Keyway)	626	RU
1 Cylinder	3080-178- CT6R	626	RU
1 Electric Strike	9500	630	HS ↘
1 SMART Pac Bridge Rectifier	2005M3		HS ↘

1 Closer (surface)	DC6210 A3 M54	689	RU
1 Wall Stop	406	US26D	RO
1 Power Supply	Furnished by security Contractor		00

Notes: FAIL SAFE ELECTRIC STRIKE (NON RATED OPENING).

Set: 12.01

Doors: 1CORR2, 2CORR3A, 2CORR4A

1 Integrated Door Assembly	All Hardware by Door Manufacturer	RI
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Notes: Integrated door assembly with electromagnetic hold opens, interfaced with smoke/fire alarm system.

Set: 13.01

Doors: 146C

8 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Manual Flush Bolt	2905	US26D	RO
1 Mortise Lockset (security entrance/classroom lock, ADA thumb turn)	ML2075 102X M34 C6	626	RU
1 Coordinator	2672	US28	RO
2 Closer (surface)	DC6210 A1 M54	689	RU
2 Kick Plate	K1050 10" X 2" LDW	US32D	RO
2 Wall Stop	406	US26D	RO
1 Gasketing	S773D		PE

END OF SECTION

SECTION 087113
AUTOMATIC DOOR OPERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. **Section Includes:**

- 1. **Low-energy door operators for accessibility and interconnected to the fire alarm and smoke evacuation systems.**
- 2. **Steel bollards, wiring and push button controls for remote control.**
- 3. **Power as required to serve door operators.**
- 4. **Control wiring connected to fire alarm and smoke evacuation systems (if any) as required.**

1.3 DEFINITIONS

- A. **Double Egress Doors:** A pair of doors that simultaneously swing with the two doors moving in opposite directions with no mullion between them.
- B. **Double Swing Doors:** A pair of doors that swing with the two doors moving in opposite directions with a mullion between them; each door functioning as a single swing door.

1.4 SUBMITTALS

- A. **Product Data:** For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators, including activation and safety devices. Include operating characteristics, electrical characteristics, and furnished accessories.
- B. **Shop Drawings:** For automatic door operators. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Indicate required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include locations and elevations of entrances showing activation and safety devices.
 - 3. Wiring Diagrams: For power, signal, and activation- and safety-device wiring.
- C. **Warranty:** Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project, and with a **minimum of ten years' experience.**
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- B. **Certified Inspector Qualifications:** Certified by the AAADM.
- C. **Source Limitations:** Obtain automatic door operators, including activation and safety devices, from single source from single manufacturer.
- D. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- E. **Exit-Door Requirements:** Comply with requirements of authorities having jurisdiction for doors with automatic door operators serving as a component of a required means of egress.

1.6 PROJECT CONDITIONS

- A. **Field Measurements:** Verify actual dimensions of door frames by field measurements before

fabrication of exposed covers for automatic door operators.

1.7 **COORDINATION**

- A. Templates: Obtain and distribute, to the parties involved, templates for doors, frames, operators, and other work specified to be factory prepared and reinforced for installing automatic door operators. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic door operators to comply with indicated requirements.
- B. **Electrical and Smoke Evacuation Systems Roughing-in:** Coordinate layout and installation of automatic door operators, including activation and safety devices, with connections to power supplies, access-control system, fire alarm and smoke evacuation systems. **General Contractor to provide required circuiting power and low voltage requirements to all locations as required for a fully operational system whether or not indicated on drawings.**

1.8 **WARRANTY**

- A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty or sporadic operation of automatic door operator, including activation and safety devices.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
 - 2. **Warranty Period: Two years** from date of Substantial Completion.

1.9 **MAINTENANCE SERVICE**

- A. **Initial Maintenance Service:** Beginning at Substantial Completion, **provide 12 months' full maintenance** by skilled employees of automatic door operator Installer. Include quarterly planned and preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.
 - 1. Engage a certified inspector to perform safety inspection after each adjustment or repair, and at end of maintenance period. Furnish completed inspection reports to Owner.
 - 2. Perform maintenance, including emergency callback service, during normal working hours.
 - 3. Include 24-hour-per-day, seven-day-per-week emergency callback service.

PART 2 - PRODUCTS

2.1 **MANUFACTURERS**

- A. **Basis-of-Design Product:** Provide concealed type units unless indicated or otherwise required. Subject to compliance with requirements, provide the following:
 - 1. **Concealed Units:** LCN Closers; 2800 Series; model as applicable to specific installation. Verify functionality with depth of frame.
 - 2. **Surface Mounted Units:** LCN Closers; 4600 Series, Auto Operator/Auto Equalizer. Model 4640 (push) and 4630 (pull) as applicable. Verify functionality with depth of frame.
 - 3. Accessories:
 - a. 3620 special template.
 - b. Provide delay contacts for emergency power circuits.
 - c. Flushbolts: Provide Von Duprin auto flushbolts at locations where flushbolts apply.
 - 4. Substitutions: None allowed.

2.2 **MATERIALS**

- A. **Aluminum:** Alloy and temper recommended by manufacturer for type of use and finish

indicated, complying with standards indicated below:

1. Sheet: ASTM B 209.
 2. Extrusions: ASTM B 221.
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.

2.3 AUTOMATIC DOOR OPERATORS, GENERAL

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated; and complying with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
1. **Emergency Breakaway:** Where indicated for center-pivoted doors, provide emergency breakaway feature for reverse swing of doors. Equip system to discontinue power to automatic door operator when door is in emergency breakaway position, and to return to closed position after breakaway and automatically reset.
 2. **Fire-Rated Doors:** Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
 3. **Wind Load:** Provide door operators on exterior doors that will open and close doors and maintain them in fully closed position when subjected to wind load of 10 psf.
- B. **Electromechanical Operating System:** Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation including spring closing when power is off.
- C. **Hinges:** See Division 08 Section "Door Hardware" for type of hinge for each door that door operator shall accommodate.
- D. **Cover for Surface-Mounted Operators:** Fabricated from 0.125-inch- thick extruded or formed aluminum; manufacturer's standard width; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.
1. **Finish: Match door finish** – Refer to Document 008900.
- E. **Brackets and Reinforcements:** Manufacturer's standard, fabricated from aluminum with non-staining, nonferrous shims for aligning system components.

2.4 LOW-ENERGY DOOR OPERATORS

- A. Standard: BHMA A156.19.
- B. **Performance Requirements:**
1. **Opening Force if Power Fails:** Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 2. **Entrapment Protection:** Not more than 15 lbf required to prevent stopped door from closing or opening.
- C. **Configuration:** Operator to control single swinging door.
1. Traffic Pattern: Two way.
 2. Operator Mounting: Surface.
- D. **Operation:** Power opening and spring closing. Provide time delay for door to remain open before initiating closing cycle as required by BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.
- E. **Operating System:** Electro-mechanical.
- F. Microprocessor Control Unit: Solid-state controls.
- G. Features:
1. Adjustable opening and closing speed.
 2. Adjustable opening force.
 3. Adjustable back-check.
 4. Adjustable hold-open time from zero to 30 seconds.
 5. Adjustable time delay.

6. Obstruction recycle.
 - H. **Exposed Finish:** Finish exposed components with finish matching door and frame.
- 2.5 **ACTIVATION AND SAFETY DEVICES**
- A. General: Provide activation and safety devices in accordance with BHMA standards, for condition of exposure and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.
 - B. **Push-Plate Switch (Exterior Locations):** Momentary-contact door control switch with flat push-plate actuator with contrasting-colored, engraved message.
 1. **Configuration:** Rectangular push plate with 2-by-4-inch junction box.
 - a. **Mounting:** As indicated on Drawings. If none indicated, provide and mount to epoxy painted 4 inch by 4 inch by 36 inch (above finish grade) steel bollard with steel top (welded), at location to be determined by the Architect.
 2. **Push-Plate Material:** Plastic for Interior application, and Stainless Steel for Exterior application, as selected by Architect from manufacturer's full range.
 3. **Message:** "Push to Open."
 - C. **Infrared Sensor (Interior Locations):** Provide above door head on interior side of doors. Manufacturer's standard.
 - D. **Handheld Remote Control Push Button Device:** Provide manufacturer's standard. **Provide four (4) devices with each unit.**
- 2.6 **FABRICATION**
- A. Factory fabricate automatic door operators to comply with indicated standards.
 - B. Fabricate exterior components to drain water passing joints and condensation and moisture occurring or migrating within operator enclosure to the exterior.
 - C. Form aluminum shapes before finishing.
 - D. **Use concealed fasteners to greatest extent possible.** Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
 - E. Provide metal cladding, completely cladding visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.
- 2.7 **ACCESSORIES**
- A. **Signage:** As required by cited BHMA standard for the type of operator.
 1. Application Process: Decals.
 2. Provide sign materials with instructions for field application when operators are installed.
 - B. Guide Rails: See Division 05 Section ".
- 2.8 **GENERAL FINISH REQUIREMENTS**
- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
 - D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- 2.9 **FINISHES**
- A. Refer to 008900 for finish and color as selected from the following:
 1. **Clear Anodic Finish:** AAMA 611, AA-M12C22A21, Class I, 0.018 mm or thicker.
 2. **Color Anodic Finish:** AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

3. **High-Performance Organic Finish:** 2-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Match finish on exterior aluminum doors and windows on the project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.
- C. Verify that full-height finger guards are installed at each door with pivot hinges where door has a clearance at hinge side greater than 1/4 inch and less than 3/4 inch with door in any position.
- D. **Proceed with installation only after unsatisfactory conditions have been corrected.**

3.2 INSTALLATION

- A. General: Install complete automatic door operators according to manufacturer's written instructions, including activation and safety devices, control wiring, and remote power units if any; connection to the building's power supply; and signage.
 1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
 2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
 3. Low-Energy Door Operator Installation Standard: BHMA A156.19.
- B. **Power Connection:** See Division 26 Sections for connection to electrical power distribution system. **Provide power, low voltage wiring to smoke evacuation and circuiting as required for a fully-operational system, whether or not shown on Drawings.** Include circuiting and power to remote push button controls and bollards as required.
- C. **Activation and Safety Devices:** Install devices and wiring according to manufacturer's written instructions and cited BHMA standard for type of operator and direction of pedestrian travel. Connect activation- and safety-device wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. **Signage:** Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 ADJUSTING

- A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 1. Adjust operators on exterior doors for weathertight closure.
- B. After completing installation of exposed, factory-finished automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
- C. Readjust automatic door operators after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- D. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.4 DEMONSTRATION

- A. Engage a certified inspector to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

3.5 SCHEDULE

A. Locations:

1. 11 Automatic door leafs at the Southeast and Northwest vestibules leading into the east Atrium 100. If activated by push button only one leaf in each bank of doors of each Vestibule shall operate. Preferably on a delay between banks to minimize air infiltration. ~~In a smoke event, all door leafs shall open at the same time. Connect to Smoke Evacuation System to open vestibule doors upon alarm condition.~~
2. At West Atrium provide one leaf at north door.

END OF SECTION

SECTION 088000

GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents: Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- B. **Section Includes** (Note: Not all of the following products may apply to this project):
 - 1. Glass for hollow metal doors and frames which are not pre-glazed.
 - 2. Fire rated glazing for doors and sidelites where required.
 - 3. Glass for interior fire rated and non-fire rated windows.
 - 4. Glass and spandrel panels for aluminum storefront, curtain wall, fixed windows, doors, and other types of window systems.
 - 5. Mirrors.
 - 6. Associated glazing sealants and accessories.
 - 7. Ceramic frit on exterior surface of glass.

1.2 SYSTEM REQUIREMENTS

- A. Design Requirements: Provide continuity of building enclosure to maintain continuous air and vapor barrier throughout glazed assembly from glass pane to heel bead of sealant.

1.3 PRECONSTRUCTION TESTING

- A. **Distortion Tolerance Testing:**
 - 1. Measure each pane of monolithic uncoated and coated heat treated glass or coated glass of 6 mm thickness or more used in the project, including glass used in the visual mockup.
 - 2. **Measurement Device:** LiteSentry measurement system or approved equal.
 - 3. **Roll Wave Criteria (horizontal):** Average 0.003 Center / 0.008 edges (peak to valley).
 - 4. **Millidipter Criteria (90% surface):** Maximum +/- 102 A overall, or the highest overall measurement from the approved visual mock-up that is less than +/- 120A overall, whichever is less, for the typical size. Non-typical size maximum remains at +/- 120.
 - 5. **Documentation:**
 - a. **Document and record the results of each pane and forward to the Architect for review.**
 - b. **Tag each pane of glass that fails outside of the maximum distortion limits and certify that these non-conforming glass panels will not be fabricated and supplied to the project.**
 - c. Provide written documentation of the Roll Wave and Millidipter measurements of the glass used in the visual mock-up before the mock-up is reviewed by the Owner and Architect for approval.
 - d. Provide additional written documentation upon request of Owner or Architect.
- B. **Bow/Warp Tolerance:**
 - 1. Maximum 1/2 of ASTM C1048.
 - 2. Measure every hour on a vertical plane with an aluminum straight edge
 - 3. Provide recorded written documentation upon request.
- C. **Bow/Warp and Air Space Measurement, Concave/Convex:**
 - 1. Measure box warp every hour on a vertical plane with an aluminum straight edge or other type of device.
 - 2. Measure center air space on all units equal to or more than 25 s.f.
 - 3. Scips and voids in the primary or secondary seals are prohibited and maximum gap at primary/secondary seal interface is 1 inch in length and 3/32 inch width.
 - 4. **Documentation:**

- a. **Document and record results and forward to the Architect for review.**
- b. **Tag each pane/unit of glass that falls outside of the maximum color variation limits and certify that non-conforming glass will not be fabrications and /or supplied to the project.**
- c. Provide additional written documentation upon request of the Owner or Architect.

1.4 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Product Data:** Manufacturer's descriptive data and recommended installation instructions for each type of glass and glazing material specified, including glazing accessories and glazing sealants.
- C. **Sustainable Submittals:** (Not Used)
 - 1. Product data for glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
- D. **Shop Drawings:** Sections and details of glass and glazing materials installation at framing members including head, mullions, transoms, jambs and sills.
- E. **Test Reports:** For each of the following types of glazing products:
 - 1. Tinted float glass.
 - 2. Low-E glass
 - 3. Insulating glass
 - 4. Safety glass
 - 5. Wire glass
 - 6. Glazing sealants
 - 7. Glazing gaskets
- F. **Warranty:** Signed and dated by manufacturer.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: Glass of each type to be produced by same manufacturer.
- B. Installer Qualifications: Minimum of **10 years successful experience** on comparable projects and approved in writing by manufacturer.
- C. Regulatory Requirements:
 - 1. Fabricate glass to comply with ASTM C1036, ASTM C1048, and ANSI Z97.1.
 - 2. Perform work in accordance with FGMA Glazing Manual for glazing installation methods.
- D. Certifications:
 - 1. Manufacturer's letter certifying glass and glazing materials compatibility
 - 2. Manufacturer's letter certifying that sealed insulating glass units meet or exceed specification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in accordance with Section 016000.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. **Perform glazing when ambient temperature is above 40°F.**
 - 2. Perform glazing on dry surfaces only.

1.8 WARRANTY

- A. Manufacturer's standard **10 year warranty** on hermetically sealed insulating glass units and for mirrors

PART 2 - PRODUCTS

2.1 GLASS MATERIALS

- A. **Single Pane, Clear and Tinted, Laminated Tempered and Un-Tempered Units.**

1. **Quality:** Glazing select, float, complying with ASTM C1036, Type I, Class 1, Quality q3.
2. **Type:** Tempered, complying with ASTM C1048, Kind FT fully tempered and untempered.
3. **Thickness:** 1/4 inch.
4. **Acceptable Manufacturers:**
 - a. PPG Industries Inc., Pittsburgh, PA
 - b. Guardian Industries Corp., Corsicana, TX
 - c. Oldcastle Glass
 - d. Pilkington
 - e. Viracon
5. **Color and Tint:** To be selected by Architect. Refer to Section 008900 - Finish Selections Summary. **Retain subparagraph below only with clear float glass and only after verifying availability.**
- B. **Exterior Insulated Glazing Units:** Refer to Section 008900 - Finish Selections Summary.
 1. **Acceptable Manufacturers:**
 - a. PPG Industries Inc., Pittsburgh, PA
 - b. Guardian Industries Corp., Corsicana, TX
 - c. Oldcastle Glass
 - d. Pilkington
 - e. Viracon
- C. **Glass for Shelves at Display Cabinets:** 3/8 inch thick, fully tempered, clear glass.
- D. **Framed Mirrors:**
 1. **ASTM C1036, mirror select quality, 1/4" clear plate. Backs shall have 2 coats of silver hermetically sealed, complying with GS-27, with an impervious protective coating of copper deposited over silver by electrolysis, and finished with a special composition hard, mirror-backing paint.** Mirrors shall bear manufacturer's labels. Mirrors shall have ground and polished edges.
 2. **Mirror Setting Mastic:** As recommended by mirror manufacturer.
 3. **Frame:** Provide continuous 1/4" by 3/8" brushed stainless steel channel trim around all mirrors.
- E. **Fire-Protection-Rated Glazing: (Not Used)** Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.
 1. **Acceptable Manufacturers:**
 - a. SafiFirst.
 - b. Firelite by Technical Glass Products.
 2. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from the hose-stream test.
 3. **Provide tempered rated glass at rated openings, where required by code whether or not indicated as such on drawings.**
 4. **Fire-Protection-Rated Glazing Labeling:** Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F (250 deg C) temperature-rise limitation; and the fire-resistance rating in minutes.
 5. **Fire-Rated Monolithic Ceramic Glazing:** Clear, ceramic flat glass; 5/16-inch nominal thickness or as called for by manufacturer.
 - a. **Basis-of-Design Products:** Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products).
 - b. **Required Fire Ratings:** Refer to Drawings, and as required by code.
 - 1) **20-minute:** Premium Firelite Plus fire rated glass at locations called for on the Drawings and per code.

- 2) **45-minute:** Pilkington Pyrostop fire rated glass at locations as called for on Drawings and per code.
- 3) **60-minute:** Pilkington Pyrostop fire rated glass at locations indicated called for on the Drawings.
- c. **Applications:** Doors, windows, and interior glazing.
- d. **Framing:** Refer to Drawings.

2.2 GLAZING ACCESSORIES

- A. **Setting Blocks:**
 - 1. Material: Preformed neoprene, compatible with sealant.
 - 2. Hardness: 80-90 Shore A durometer
 - 3. Size: 0.10 inch for each square foot of glazing, not less than 4 inch length x width of channel minus 1/16 inch x 1/4 inch high.
 - 4. Location: Sill quarter points, centered minimum 4 inches from each edge.
 - 5. Requirement: Resistant to sunlight, weathering oxidation and permanent deformation under load.
- B. **Spacer Shims:**
 - 1. Material: Preformed neoprene, compatible with sealant.
 - 2. Hardness: 50-60 Shore A durometer.
 - 3. Size: Minimum 3 inch length x 1/2 height of glazing stop x thickness to suit application.
- C. **Edge Blocks:**
 - 1. Material: Preformed neoprene, compatible with sealant.
 - 2. Hardness: 60-70 Shore A durometer.
 - 3. Size: Minimum 4 inch length x width to support thickness of glass, allow nominal 1/8 inch clearance between edge of glass and edge bumper.
 - 4. Location: Place in vertical channel.
 - 5. Requirement: Resistant to sunlight, weathering, oxidation and permanent deformation under load.
- D. **Dense Compression Gaskets:** Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 - 1. EPDM complying with ASTM C 864.
 - 2. Silicone complying with ASTM C 1115.
- E. **Glazing Tapes:**
 - 1. Material: Preformed butyl or closed cell PVC foam with integral spacing device and containing paper release.
 - 2. Hardness: 10-15 Shore A durometer.
 - 3. Size: Continuous corner to corner.
 - 4. **Acceptable Products:**
 - a. Pre-Shimmed 440 Tape, Tremco, Cleveland, OH.
 - b. 330 Glazing Tape, PTI, Dayton, OH
 - 5. Glazing Tape: as required to maintain fire rating of tested assembly.
 - 6. Setting Blocks: as required to maintain fire rating of tested assembly.
- F. **1/4-inch x 3/8-inch high polished stainless steel channel trim.** Provide continuous channel trim around all mirrors.
- G. **Glazing Film:**
 - 1. Provide vinyl glazing film at locations indicated on the Drawings. Final artwork to be provided by Architect. Film shall be applied on the outside surface of the glass.
 - 2. Submit 12" x 12" color samples on required substrates for Architect approval.
 - 3. **Acceptable Product:** To be selected by Architect from full and complete line of manufacturers products.

2.3 GLAZING SEALANTS

- A. **Polyurethane (Type Sealant):**

1. Single component, complying with FS TT-S-00230C, Type II, Class A, and ASTM C920, Type S, Grade NS, Class 25
2. Moisture curing
3. Hardness: 20-35 Shore A durometer
4. Non-sagging, non-bleeding, non-staining
5. Color as selected by the Architect.
6. **Acceptable products:**
 - a. Sonolastic NP-1, Sonneborn Building Products, Minneapolis, MN
 - b. Dymonic, Tremco, Cleveland, OH
 - c. Dynatrol I, Pecora Corporation, Harleysville, PA

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 014000.
- B. Verify that openings for glazing are correctly sized and within tolerances.
- C. Verify that glazing channel surfaces or recesses are clear, free of burrs, obstructions, irregularities, and glass is free of edge damage or imperfections.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant, if required by sealant manufacturer.
- D. Verify that materials used for cleaning edges of sealed insulating units are compatible with sealants and components and will not damage or cause deterioration of the integrity of the sealed insulating unit.

3.3 INSTALLATION

- A. Install glass units in accordance with manufacturer's printed instructions. **Ensure weep and drainage holes are not blocked by sealants or setting blocks.**
- B. **Preformed Glazing Gaskets (Dry Method):**
 1. Cut gasket to proper length.
 2. Weld joints by butting gasket and sealing junctions with sealant.
 3. Place setting blocks at quarter points, with edge blocks no more than 6 inches from corner.
 4. Rest glass on setting blocks and push against stop with sufficient pressure to ensure full contact and adhesion at perimeter.
 5. Install removable stops, avoiding displacement of gasket and exert pressure for full continuous contact.
 6. Install fixed aluminum window glass in gaskets.
- C. **Interior Dry Method (Tape and Tape):**
 1. Cut glazing tape to length and install against permanent stop, projecting 1/16 inch above sight line.
 2. Place setting blocks at 1/4 points with edge blocks no more than 6 inches from corners.
 3. Rest glass on setting blocks and push against stop for full contact and adhesion at perimeter.
 4. Place glazing tape on free perimeter of glass in same manner described above.
 5. Install removable stop, avoid displacement of tape, exert pressure on tape for full continuous contact.
 6. Knife trim excess or protruding tape.
- D. **Tempered and Fire Rated Glass:**
 1. Do not cut, seam, nip or abrade tempered or fire rated glass.
 2. Set fire rated glass lites with proper orientation so that coatings face fire side or protected side as specified.

3. **Provide and install tempered and fire rated glass in all doors, windows and sidelights where required by code whether or not called for on Drawings.**

3.4 GLASS MIRRORS

- A. Apply one additional coat of moisture-resistant paint, type recommended by manufacturer, to back of mirror.
- B. Allow to dry.
- C. Apply mirror mastic to cover not more than 25% of back mirror, 1/8" to 1/2" thickness of setting bed.
- D. Set mirror on concealed shelf angle.
- E. Press mirror against substrate to bond.
- F. Leave open ventilation space, 1/8" minimum between mirror and substrate.
- G. Do not seal off ventilation space at edge of mirror.

3.5 PROTECTION

- A. Protect finished Work under provisions of Section 015000.
- B. After installation, mark glass pane with an "X" by using removable plastic tape or paste.

3.6 CLEANING

- A. Clean work under provision of Section 017400.
- B. Remove excess glazing materials from finished surfaces.
- C. Remove labels after work is completed.
- D. Wash and polish both faces not more than 7 days prior to Owner's acceptance of work.
- E. Comply with glass manufacturer's recommendations for final cleaning.

3.7 SCHEDULE

- A. **Exterior 1" Insulating Units (Fritted and Unfritted Units):** Provide at all exterior curtainwall, fixed windows, storefront and entrance locations. Refer to Drawings for frit locations.
- B. **Interior 1" Acoustical Units:** Provide at interior atrium storefront.
- C. **Channel Glass Insulating Units (blue):** Provide at 3rd floor Nursing Skills Lab north and east elevations.
- D. **1/4" Thick Clear Glass:** Provide at interior locations as indicated on plans.
- E. **Vinyl Film:** Provide at east Atrium north wall, 1" thick acoustical units at 4th floor from finish floor to 48" above finish floor.
- F. **Decorative Tempered Glass:** Provide at first floor elevators east opening to 8'-0" AFF.
- G. **Interior 1" Thick Spandrel Glass Units with Ceramic Frit on Second Surface:** Provide at storefront spandrel locations at each floor of the atrium.

END OF SECTION

SECTION 089100

LOUVERS

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 SECTION INCLUDES
 - A. **Architectural grade metal wall louvers.**
 - B. **Refer to mechanical specifications for additional information on required free area.**
- 1.3 SUBMITTALS
 - A. General: Submit in accordance with Section 013300.
 - B. **Product Data:**
 - 1. Descriptive data of louvers including standard drawings, louver free area, maximum recommended air velocity, materials and finishes.
 - C. **Shop Drawings:**
 - 1. Include details of fabrication and erection, anchorage and accessories.
 - 2. Indicate elevations, dimensions and tolerances, blade configuration and screening.
 - D. Certificates: Submit manufacturer's certification that materials meet specification standards.
 - E. Manufacturer's Instructions: Submit manufacturer's installation instructions.
- 1.4 FIELD MEASUREMENTS
 - A. Verify that field measurements are as indicated on shop drawings.
- 1.5 DELIVERY, STORAGE AND HANDLING
 - A. Deliver, store, and handle products in accordance with Section 016000.
- 1.6 COORDINATION
 - A. Coordinate work under provisions of Section 013100.
 - B. Coordinate work with installation of exterior insulation and finish system.

PART 2 - PRODUCTS

- 2.1 **ACCEPTABLE MANUFACTURERS AND PRODUCTS**
 - A. Airolite Company, LLC (The).
 - B. Construction Specialties, Inc.
 - C. Greenheck Fan Corporation.
 - D. Ruskin Company; Tomkins PLC.
 - E. Substitutions: Submit in accordance with Section 016000.
- 2.2 **METAL WALL LOUVERS**
 - A. Wall louvers of sizes indicated on Drawings or otherwise required.
 - B. **Basis of Design:**
 - 1. **Manufacturer:** Construction Specialties.
 - 2. **Product:** Model A4097 Drainable 4" louver.
 - 3. **Free Area:** 50.4 percent minimum.

2.3 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.

2.4 ACCESSORIES

- A. **Insect Screen:** 18 by 16 size aluminum mesh, set in frame of same material as screen.
- B. Sealants: Type as specified in Section 079000.
- C. Fasteners: Manufacturer's standard, compatible with fabricated items.

2.5 FABRICATION

- A. Fabricate units as indicated on Drawings.
- B. Screens: Permanently install screen mesh in shaped frame with reinforced corner construction; screw to louver frame.
- C. Fabricate units rigid, neat in appearance, and free from defects, warp or buckle.
- D. Dress exposed welds for smooth flush appearance.

2.6 FINISHES

- A. Refer to 008900 for finish and color as selected from the following:
 - 1. **Clear Anodic Finish:** AAMA 611, AA-M12C22A21, Class I, 0.018 mm or thicker.
 - 2. **Color Anodic Finish:** AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 3. **High-Performance Organic Finish:** **2-coat fluoropolymer finish** complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 014300.
- B. Verify that prepared openings are ready to receive work and opening dimensions are as indicated on the shop drawings.
- C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturer's printed instructions.
- B. Install louvers level and plumb.
- C. Secure louvers in opening framing with concealed fasteners wherever possible.
- D. Apply bituminous protective coating to aluminum surfaces in contact with dissimilar metals.
- E. Align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- F. Form tight joints with exposed connections accurately fitted together.
- G. Install insect screening to interior of louver.
- H. Install perimeter sealant and backing rod in accordance with Section 07 90 00.

3.3 CLEANING

- A. Repair damage to louvers and screens as a result of cutting, grinding, or welding to match original condition.
- B. Clean surfaces and components to remove foreign substances.

3.4 SCHEDULE

- A. Provide at the following locations and as otherwise called for on architectural and mechanical drawings:

1. Intake and exhaust air grilles at Penthouse.
2. Exhaust grille for smoke evacuation at Classroom 102.

END OF SECTION

SECTION 092900

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 **SECTION INCLUDES**
 - A. **Fire rated and abuse resistant gypsum board.**
 - B. **Mold resistant gypsum board.**
 - C. **Glass mat tile backing board.**
 - D. **Resilient furring.**
 - E. **Taped and sanded joint treatment.**
 - F. **Texturing gypsum board finish.**
 - G. **Drywall framing systems.**
- 1.3 SUBMITTALS
 - A. Submit under provisions of Section 013300.
 - B. **Product Data:** Provide data on all products proposed for use.
 - C. **Texture Samples:** Submit two samples gypsum board texture, 16 by 16 inch in size, illustrating finish texture.
- 1.4 QUALITY ASSURANCE
 - A. Perform Work in accordance with ASTM C840, GA-201, GA-216 and GA-600.
 - B. Maintain environmental conditions as recommended by manufacturer prior to beginning joint treatment work.
- 1.5 DELIVERY, STORAGE, HANDLING
 - A. Deliver, store, handle, and protect products in conformance with manufacturer's instructions and in accordance with Section 016000.
 - B. Store inside building, on sleepers, and out of water.
- 1.6 QUALIFICATIONS
 - A. Applicator: Company specializing in performing the work of this section with **minimum 10 years documented experience.**
- 1.7 REGULATORY REQUIREMENTS
 - A. Conform to applicable code for fire rated assemblies.

PART 2 - PRODUCTS

- 2.1 **ACCEPTABLE MANUFACTURERS - GYPSUM BOARD SYSTEM**
 - A. National Gypsum.
 - B. Georgia Pacific.
 - C. USG Corp.
- 2.2 **GYPSUM BOARD MATERIALS**
 - A. **Fire Rated Gypsum Board:** ASTM C 1396; 48 inch wide, maximum permissible length; ends square cut, tapered and beveled edges.

1. **Core: 5/8 inch thick, Type X.**
 2. **Basis-of-Design:** USG Corp.; Sheetrock Firecode Core.
- B. **Moisture-Resistant Gypsum Board:** With moisture- and mold-resistant core and surfaces; ASTM C 1396; 48 inch wide, maximum permissible length; ends square cut, tapered and beveled edges.
1. **Core: 5/8 inch thick, Type X.**
 2. **Mold Resistance:** ASTM D 3273, score of 10.
 3. **Basis-of-Design:** Sheetrock Mold Tough Firecode Gypsum Board.
- C. **Abuse-Resistant Gypsum Board:** Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board; 48 inch wide, maximum permissible length; ends square cut, tapered and beveled edges.
1. **Core: 5/8 inch thick, Type X.**
 2. **Basis-of-Design:** USG; Sheetrock AR Firecode Core.
- D. **Acoustically Enhanced Gypsum Board:** ASTM C 1396; multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core; 48 inch wide, maximum permissible length; ends square cut, tapered and beveled edges.
1. **Core: 5/8 inch thick, Type X.**
 2. **Basis-of-Design:** National Gypsum; SoundBreak
 3. **Additional Acceptable Manufacturers:**
 - a. Quiet Solution.
- 2.3 **TILE BACKING PANELS**
- A. **Glass-Mat, Water-Resistant Backing Board:** ASTM C 1178, with manufacturer's standard edges.
1. **Core: 5/8 inch thick, Type X.**
 2. **Mold Resistance:** ASTM D 3273, score of 10.
 3. **Basis of Design:** Georgia Pacific; DensShield Tile Backer.
- B. **Cementitious Backer Units:**
1. ANSI A118.9 or ASTM C 1325; cementitious panels composed of portland cement, aggregates, glass mesh on both faces, and manufacturer's proprietary ingredients; capable of remaining unaffected by prolonged exposure to water; 1/4, 1/2, and 5/8 inch thick.
 2. **Acceptable Manufacturers:**
 - a. Custom Building Products.
 - b. FinPan, Inc.
 - c. National Gypsum Co.
 - d. USG Corp.
- 2.4 **FRAMING MATERIALS**
- A. **Studs and Tracks:** ASTM C 645; galvanized sheet steel, gage per manufacturer's span charts, 'ST' series shape, depths as indicated on Drawings. Provide with floor and ceiling runners, 'C' shaped galvanized, 1-1/4 inch leg.
1. **Thicknesses:** 20 gage, 25 gage, and others as required. Coordinate with Architect.
- B. **Firestop Slip Tracks:** Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. **Basis of Design:** BlazeFrame Fire Stop Deflection Track.
- C. **Flexible Track for Studs:** Galvanized steel flexible track and strap system designed to receive studs for framing curves; component sizes as indicated on Drawings.
1. **Galvanized Steel:** ASTM A 653, gage and grade as required for application.
 2. **Basis of Design:** Flex-Ability Concepts; Flex-C Trac.

- D. **Grid Suspension System for Gypsum Board Ceilings:** ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. **Acceptable Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.
- E. **Furring, Framing and Accessories:** Provide in conformance with ASTM C 645, GA-216, and GA-600 and as follows:
 - 1. **Cold Rolled Channels:** 3/4 inch, 1-1/2 inch and 2 inches, 16 gage, prime painted.
 - 2. **Furring Channels:** 7/8 inch deep x 1-1/4 inch face, 25 gage, galvanized.
 - 3. **Resilient Furring:** 7/8 x 7/8 inch cold-rolled channels.
- F. **Fasteners:** ASTM C 1002 for screws as follows:
 - 1. Inserts, clips, bolts, nails or other screws as recommended by wallboard manufacturer, of type and size to suit application and to rigidly secure materials in place.
 - 2. Self-drilling, self-tapping bugle head screws for use with power drive tool.
 - 3. **Metal Framing to Structure:** Power driven screw fasteners to withstand 190 pound single shear resistance and 200 pound bearing force when drive through structural head or base and without exceeding allowable design stress in runner, fastener, or structural support.
 - 4. **Metal to Metal:** 3/8 inch, Type S or S-12, pan head screws.
 - 5. **Gypsum Board to Sheet Metal Application:** Type S screws.
 - 6. **Gypsum Board to Gypsum Board Application:** Type G screws.
- G. **Adhesive:** Utilize adhesive meeting requirements of GA-216 over metal framing.

2.5 ACCESSORIES

- A. U. S. Gypsum Company products specified below as a standard of quality, unless noted otherwise.
 - 1. **Acoustical Sealant:** Non-hardening, non- skinning, for use in conjunction with gypsum board; manufactured by Tremco, or USG.
 - 2. **Corner Beads:** Metal, Durabead No. 103, galvanized.
 - 3. **Casing Beads:** No. 200-A, galvanized, except vinyl J-mold at unit windows
 - 4. **Control Joint:** No. 093, galvanized.
 - 5. **Reveal:** Continuous architectural reveals where noted on drawings. (Note: Some or all of these products may not be used on this project, refer to Drawings.)
 - a. **Acceptable Products:**
 - 1) Fry Reglet; 5/8 x 5/8 inches, GWB Reveal, DRM-625-625.
 - 2) Fry Reglet; 5/8 x 3/4 inches, GWB Reveal, DRM-625-75.
 - 3) Fry Reglet:
 - a) Column Ring at Gypsum Board: GWB Reveal DRWT-75-75.
 - b) ACT Ceiling: Reveal WRM-75-75-625.
 - 6. **Joint Tape:**
 - a. **ASTM C475 or FS SS-J-570, Type II, perforated tape**
 - 7. **Joint Compound:**
 - a. **ASTM C475 or FS SS-J-570, Type I**
 - b. **Acceptable product:**
 - 1) Taping compound: USG Durabond Joint Compound Taping.
 - 2) Topping: USG Joint Compound-All Purpose
 - c. **Use special joint compound as recommended by manufacturer for exterior gypsum ceiling board.**
- B. **Steel Drill Screws:** ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. **Resilient Channels:** Formed steel; minimum 25 gage thick; size and length as required, serrated face, Z-shaped profile; equal to U.S.G. model RC-1, 2-1/2 inch wide x 1/2 inch deep, spaced at 24 inches O.C.
- D. **Cover for Wall at Exterior Windows:**
 1. **Basis of Design:**
 - a. **Manufacturer:** Mull-It-Over Products.
 - b. **Product:** Mull-It-Over.
 - c. **STC:** Not less than 55.
 - d. ~~**Finish:** Painted color to match wall color.~~
 - e. **At Mullion:** 55 Classic.
 - f. **At Glazing:** 60 Classic (At No Window Mullion).

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that site conditions are ready to receive work and opening dimensions are as indicated or instructed by the manufacturer. Report in writing to project superintendent, any defects which would prevent proper execution of the work of this section in accordance with tolerances indicated. Surfaces are to be true and flat, without warps, waves, distortions, or other irregularities.
- B. Beginning of installation means acceptance of existing substrate.

3.2 ACOUSTICAL ACCESSORIES INSTALLATION

- A. Install acoustical sealant at wall perimeter of drywall partitions as follows:
 1. **Metal Stud Framing:** One bead at contact area of all intersecting walls, floors, and ceilings. Refer to Section 079200 for sealant material to be utilized.
 2. **Base Layer Gypsum Board:** One bead.
 3. **Seal all penetrations of partitions** by conduit, pipe, ductwork, rough-in boxes, and access door frames.

3.3 INSTALLING GYPSUM CEILING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 1. **Install hangers vertically, plumb and free from contact with insulation or other objects** within ceiling plenum that are not part of supporting structural or suspension system.
 - a. **Splay hangers only in rare instances (where no other options are available) to miss obstructions. Offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.**
 2. **Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.**
 3. **Flat Hangers:** Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. **Do not attach hangers to steel roof deck.**

5. **Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.**
 6. **Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.**
 7. **Do not connect or suspend steel framing from ducts, pipes, or conduit.**
 - D. **Fire-Resistance-Rated Assemblies:** Wire tie furring channels to supports.
 - E. **Grid Suspension Systems:** Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- 3.4 METAL STUD INSTALLATION
- A. Follow recommendations of U.S. Gypsum Co., "Gypsum Construction Handbook".
 - B. Install studding in accordance with ASTM C 754, GA-201, GA- 216, and GA-600.
 - C. **Metal Stud Spacing: 16 inches on center, unless otherwise noted in schedule or on Drawings.** Locate studs maximum of 2 inches from door frames, abutting partitions, corners, and other construction features.
 - D. **Stud to Ceiling or Structure:** Refer to Drawings for indication of partitions extending to finished ceiling only and for partitions extending through the ceiling to the structure above. **Maintain clearance under structural building members to avoid deflection transfer to studs. Provide extended leg "slip track" ceiling runners and connect after structure is fully loaded. Install additional supports as necessary.**
 - E. **Door Opening Framing:** Install double studs at door frame jambs. Install stud tracks on each side of opening, at frame head height, and between studs and adjacent studs.
 - F. **Blocking:** Screw wood blocking to studs. Bolt or screw steel channels to studs. Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, shelving, toilet accessories, and hardware.
 - G. Coordinate installation of bucks, anchors, blocking, electrical and mechanical work placed in or behind partition framing.
 - H. **Stud Connections:** Secure studs to runners with screws at door and window frames, partition intersections and corners. Use longest available steel lengths. **Where required for additional height, splice studs** by nesting a minimum lap of 18 inches and attach flanges together with 2 screws in each flange. Prevent structural loading of stud systems.
 - I. **Restroom Chase Wall Studs:** Position double row of studs vertically in runners so that studs are opposite each other in pairs with flanges pointed in same direction. Space at 16 inches on center unless otherwise noted. Anchor each stud to runner flanges with screws. **Cross brace between rows of studs with wallboard, 12 inches by chase width, screw attached to stud webs at quarter points in partition height, with 1 inch screws spaced 8" off center in each stud web.**
- 3.5 FURRING CHANNEL INSTALLATION
- A. Space resilient channels at maximum 16 inches on center for suspended gypsum board applications where indicated. Place joints over framing members. .
- 3.6 GYPSUM BOARD INSTALLATION
- A. Install gypsum board in accordance with GA 201, GA 216, GA-600, and U.S.G. "Gypsum Construction Handbook".
 - B. Pre-install gypsum board prior to furr down installation and tub/shower installations.
 - C. **Erect board horizontally** with ends and edges occurring over firm bearing. Stagger end joints to occur at different locations on opposite sides of wall. Apply board to resilient clips at ceilings with long dimension at right angles to framing.
 - D. Abutt boards without forcing. Neatly fit ends and edges of boards and make cuts and penetrations so that paper facing and gypsum core are not damaged.
 - E. **Use screws when fastening gypsum board to metal furring or framing.** Stagger fasteners opposite each other on adjacent ends and edges. Space fasteners as recommended in U.S.G., "Gypsum Construction Handbook".

- F. **Double Layer Applications:** Place first layer perpendicular to framing or furring members. Place second layer parallel to first layer. Offset joints of second layer from joints of first layer.
 - G. Install tile backing board over stud framing in accordance with manufacturer's instructions.
 - H. Install mold-resistant gypsum board and tile backer board over stud framing (or over base layer of gypsum board) in accordance with manufacturer's instructions. Install factory edges adjacent to fixtures.
 - I. **Place corner beads at all external corners.** Use longest practical length. Place edge trim where gypsum board abutts dissimilar materials.
 - J. On fire rated assemblies, seal all penetrations and make air-tight. Refer to Section 078400 for firestopping requirements and materials.
 - K. Thicken partitions to eliminate wall surface jogs for the full length of the wall within a room to conceal structural members, pipes, panels, specialty items, and accessories. Verify with Architect before beginning installation.
 - L. Coordinate door and other frame thicknesses with wall thicknesses as required.
 - M. **At curved barrel vaulted ceiling and walls, use flexible track for studs and joists. Do not construct curved framing from a segmented stud track.**
- 3.7 APPLYING TILE BACKING PANELS
- A. **Glass-Mat, Water-Resistant Backing Panels:** Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated. Install with 1/4-inch 6.4-mm gap where panels abut other construction or penetrations.
 - B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.
- 3.8 JOINT TREATMENT
- A. Tape, fill, and sand exposed joints, edges, and corners to produce surface ready to receive finishes. **The intent of this paragraph is to provide the highest quality of joint treatment work consistent with commercial construction.** Unless noted otherwise, texturing work will be applied prior to painting. Prior to texturing, leave surfaces smooth, uniform, and free of fins, depressions, ridges, cracks, and other imperfections.
 - B. Feather coats onto adjoining surfaces so that camber is maximum 1/32 inch.
 - C. Taping, filling, and sanding at attachment locations are not required at surfaces behind adhesive applied ceramic tile.
 - D. Tape all joints in fire rated partitions and wrapping where concealed from view.
 - E. **Texture:** Unless noted otherwise:
 - 1. Wall texture to be light sprayed on texture and knocked down with a metal blade. Confirm final texture with Architect.
 - 2. Painted gypsum ceilings shall be smooth with no texture.
- 3.9 TOLERANCES
- A. Maximum Variation from True Flatness: 1/8 inch in 10 feet in any direction.
- 3.10 SCHEDULE
- A. **Abuse-Resistant Gypsum Board (Type X):** Provide to 8'-0" AFF at painted wall surfaces or behind wall covering at all interior public Corridors, Elevator Lobbies, Vestibules, Stairwells, Atrium, Classrooms, Labs and other high traffic areas of the building.
 - B. **Moisture Resistant Gypsum Board (Type X):**
 - 1. Provide at interior surface of all exterior walls.
 - 2. Provide at all walls and ceilings of Restrooms, all walls of Mechanical Rooms, Janitor Closets, Kitchen and rooms with finish floors below grade.
 - C. **Cementitious Backer Board or Glass-Mat, Water-Resistant Backing Board:**
 - 1. Provide behind all ceramic wall tile.
 - D. **Lead Lined Gypsum Board:**

1. Provide at walls of the 5 energized X-ray rooms on second floor.
- E. **Fire Rated Gypsum Board (Type X):**
1. Provide at all other locations in the building not listed above.

END OF SECTION

SECTION 093000

TILING

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 SECTION INCLUDES
 - A. **Ceramic tile floor, base, and wall surfacing, installed using the thinset method with cementitious grouted joints.**
 - B. **Ceramic tile floors installed using thickset method with cementitious grouted joints. (Not Used)**
 - C. **Marble thresholds at flooring transitions.**
- 1.3 QUALITY ASSURANCE
 - A. Conform to ANSI- Recommended Standard Specifications for Ceramic Tile - A137.1.
 - B. **Conform to TCA Ceramic Tile: The Installation Handbook.**
 - C. Single source for setting products: Provide mortar, grout, waterproofing, and anti-fracture membrane from a single source/manufacturer unless otherwise approved by Architect and Owner.
 - D. **Provide final lighting or a minimum of 80 foot candles of temporary lighting in areas where tile is being installed.**
 - E. **Uncover finished tile work immediately after completing for Architect's inspection, prior to covering tile for protection from other trades.**
- 1.4 SUBMITTALS
 - A. **Submit product data** under provisions of Section 013300.
 - B. Submit product data, specifications, and instruction for using mortars, adhesives and grouts.
 - C. **Submit representative color samples** of each type tile and grout proposed for use under provisions of Section 013300.
- 1.5 ENVIRONMENTAL REQUIREMENTS
 - A. Do not install adhesives in a closed, unventilated environment.
 - B. **Maintain 50 degrees F during installation of mortar materials.**

PART 2 - PRODUCTS

- 2.1 **ACCEPTABLE TILE MANUFACTURERS**
 - A. **Refer Section 008900.**
 - B. Substitutions: Under provisions of Section 016000.
- 2.2 **TILE MATERIALS**
 - A. **Ceramic Wall Tile:**
 - 1. Grade: ANSI/A137.1; 5.0 to 10.0 percent water absorption.
 - 2. **Edge:** Cushioned.
 - 3. **Base:** Matching base units, 4 inches high unless noted otherwise on Drawings or Finish Schedule.
 - 4. **Size, Color, Finish, and Acceptable Product:** Refer Section 008900 and Finish Plans.
 - 5. **All tile shall be rectified and certified.**
 - B. **Ceramic Floor Tile:**
 - 1. Grade: ANSI/A137.1; 5.0 to 10.0 percent water absorption.
 - 2. **Edge:** Cushioned.

3. **Size, Color, Finish, and Acceptable Product:** Refer Section 008900 and Finish Plans.
 4. **All tile shall be rectified and certified.**
 - C. **Trimmers**
 1. Provide necessary matching caps, cove base, indicated outside corners, stops, returns, trimmers and other shapes to complete installation.
 2. Color and finish to match adjacent tile.
 - D. **Thresholds:** Provide white marble thresholds at transitions and doorways whether or not shown on drawings.
- 2.3 **ACCEPTABLE MORTAR, GROUT, AND ADHESIVE MANUFACTURERS**
- A. **Laticrete.**
 - B. **Mapei.**
 - C. **Custom Building Products.**
 - D. **Bostik.**
- 2.4 **FLOOR MORTAR MATERIALS - THICKSET BEDS**
- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
- 2.5 **FLOOR MORTAR MATERIALS - THIN SET BEDS**
- A. Mortar Bed: ANSI A118.4 thinset bond coat, dry-set cementitious mortar.
- 2.6 **WALL MORTAR MATERIALS**
- A. Mortar: ANSI A118.4 non-sag dry-set cementitious mortar. Adhesives not permitted.
- 2.7 **GROUT TYPE**
- A. **Wall Applications:**
 1. Grade: ANSI A118.6, cementitious dry cure type, un-sanded for walls.
 2. Additives: Latex for strength and acid resistance.
 - B. **Floor Applications:**
 1. **Water-Cleanable Epoxy Grout:** ANSI A118.3.
 2. **Basis of Design:** Laticrete SpectraLOCK PRO (Part AB Liquid) with Laticrete SpectraLOCK Powder (Part C).
 - C. **Colors:** Refer to Section 008900.
- 2.8 **MORTAR MIX AND GROUT**
- A. Mix and proportion pre-mix setting bed mortar, adhesives, and grout materials in accordance with manufacturer's instructions.
- 2.9 **MEMBRANES**
- A. **Anti-Fracture and Waterproofing Membrane:**
 1. Description: Manufacturer's proprietary elastomeric compound formulated for use as heavy duty crack isolation and waterproof membrane under tile floors.
 2. **Basis of Design: #9235 by Laticrete International, Inc.**
 3. **Acceptable Products:**
 - a. Planicrete W by Mapei
 - b. NobleSeal TS by The Noble Company, Grand Haven, MI
 4. **Install anti-fracture membrane over cracks in concrete slabs on grade and at cracks in elevated floor slabs beneath ceramic tile installations.**
 5. **Install continuous waterproofing membrane throughout all elevated restroom, shower, and kitchen floors scheduled to receive ceramic tile. Continue membrane 8" up all walls in these areas.**
 - B. **Uncoupling Sheet:**
 1. ~~**Chlorinated Polyethylene Sheet:** Non-plasticized, chlorinated polyethylene faced on the bottom side with non-woven polyester fabric; 1/8 inch nominal thickness.~~
 2. **Acceptable Products:**

- a. ~~Schluter Systems L.P.; DITRA.~~
3. ~~**Install uncoupling sheet product under all tiled areas of the building including, but not limited to lobbies, restrooms, elevators, corridors, public restrooms, and public corridors. Recess slab in these areas as required to provide a level floor surfaces between tiled areas and adjacent floor finishes.**~~

2.10 TILE BACKING PANELS

- A. Refer Section 092900.

2.11 ACCESSORIES

- A. **Wall Tile Reveal** (1/2" high by 3/8" deep): Schluter Model # Deco SG125AE12; satin aluminum continuous reveals.
- B. **TEC-1 Edge Closure**: Schluter Schiene, thickness as required; stainless steel finish. Provide sample to Architect attached to specified tile for approval.
- C. **TEC-2 Edge Closure**: Schluter Rondee; #4 brushed finish. Confirm locations during submittal process with Design Architect.
- D. **Stair Nosing**: Schluter Trep-E in stainless steel finish.
- E. **Stainless Steel Starter Course Trim (Not Used)**: 1/8" thick custom fabricated stainless steel starter course trim for use in ceramic tile wall; #4 brushed finish.
- F. **Stainless Steel Tile Edge Trim (Not Used)**: 1/8" thick custom fabricated stainless steel edge trim; #4 brushed finish.
- G. **Control Joint A**: Schluter Dilex MPV15 or MPV 25 as required. Provide at typical tile control joints and/or above saw cut joints in the concrete slab below. Confirm color and final location with Architect.
- H. **Marble Thresholds**: ASTM C 503, with a minimum abrasion resistance of 12 according to ASTM C 1353 or ASTM C 241 and with honed finish.
1. **Basis of Design**: Uniform, fine- to medium-grained white marble with white or gray veining.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that areas to receive tile installed by thin bed method have wood float finish, are true within 1/4 inch in 10'-0", and are pitched to drains where required.
- B. Condition of Surfaces to Receive Tile:
1. Surface to be firm, dry, clean, and free of oily or waxy films, mortar, slag or soil.
 2. Install grounds, anchors, plugs, hangers, bucks, electrical and mechanical work in or behind tile prior to proceeding with tile work.
 3. Wet down or wash dry, dusty masonry or concrete surfaces and remove excess water immediately prior to application of tiles.
- C. Beginning of work constitutes acceptance of substrate surfaces.
- D. Apply additional adhesive or floor filler as required to level adjoining tiles of varying thicknesses.

3.2 INSTALLATION

- A. **Anti-Fracture Membrane**
1. **Install anti-fracture membrane over all cracks of 1/16 inch or greater in substrates.**
Apply a 12 inch wide strip centered on crack. Install in accordance with manufacturer's recommendations.
- B. **Waterproofing Membrane**
1. Install waterproofing membrane in strict compliance with manufacturer's instructions.
 2. **Install waterproofing membrane on entire floor area under tile at elevated floor slabs and continue waterproofing up adjacent walls a minimum of 8 inches. Flash in around floor drains.**
- C. **Uncoupling Sheet**:

1. Install uncoupling sheet per manufacturer's instructions at all tiled floor areas of the building. Recess slab to provide level finish floor with other finishes in the building.
- D. **Tile Installation, General:**
1. **Install ceramic tile, thresholds, and base in accordance with ANSI/TCA A108.5, TCA Installation Specifications for substrate encountered, and in compliance with instructions of manufacturer of setting and grouting materials.**
 2. Cut and fit tile tight to protrusions and vertical interruptions. Form corners and bases neatly.
 3. Work tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joint watertight, without voids, cracks, excess mortar, or grout.
 4. Prepare surface, fit, set, bond, grout, and clean in accordance with applicable requirements of ANSI standards and **Tile Council of North America**.
 - a. **Floors:**
 - 1) Thinset: TCA F114.
 - 2) Thickset: TCA F112
 - 3) Thickset on Waterproofing: TCA F121.
 - b. **Walls:**
 - 1) Thinset on gypsum board or cementitious backer boards: TCA W243
 - 2) Thinset on coated glass-mat gypsum backer board: TCA B419
- E. **Layout**
1. **Lay out work per drawings** or, if none provided, so that full tile or joint is centered on each wall and no tile of less than half width need be used. Do not interrupt pattern through openings.
 2. For heights stated in feet and inches, use courses of full tile to produce nearest attainable heights without cutting tile.
 3. No staggered joints will be permitted unless indicated on drawings.
 4. Align joints in tile both directions.
 5. **Align joints between floor and base tile.**
 6. Make joints between sheets of tile exactly same width as joints within sheet.
 7. File edges of cut tile smooth and even.
 8. **Provide final lighting or a minimum of 80 foot candles of temporary lighting in areas to receive tile prior to installation.**
- F. **Thin Set Method**
1. **Install uncoupling sheet** product, anti-fracture membrane, and/or waterproofing membrane according to manufacturer's instructions.
 2. Apply mortar or adhesive with notched trowel using scraping motion to work material into good contact with surface to be covered. Maintain 90 percent coverage on back of tile and fully bed corners.
 3. Apply only as much mortar or adhesive as can be covered within allowable windows as recommended by mortar or adhesive manufacturer or while surface is still tacky.
 4. When installing large tiles, ceramics or mosaics, trowel small quantity of mortar or adhesive onto back of each tile or sheet of tiles.
 5. Set tiles in place and rub or beat with small beating block.
 6. Beat or rap tile to ensure proper bond and also to level surface of tile.
 7. Align tile to show uniform joints and allow to set until firm.
 8. Clean excess mortar or adhesive from surface of tile with wet cheese cloth (not a sponge) while mortar is fresh.
 9. Sound tile after setting. Replace hollow sounding tiles.
- G. **Thick Set Method:**
1. **Install uncoupling sheet, anti-fracture membrane, and waterproofing membrane** in accordance with manufacturer's instructions.
 2. Apply mortar bed to a minimum thickness of 1 inch.

3. Apply mortar bond coat.
4. Apply mortar with notched trowel using scraping motion to work material into good contact with surface to be covered. Maintain 90 percent coverage on back of tile and fully bed corners.
5. Apply only as much mortar as can be covered within allowable windows as recommended by mortar manufacturer or while surface is still tacky.
6. Set tiles in place and rub or beat with small beating block.
7. Beat or rap tile to ensure proper bond and also to level surface of tile.
8. Align tile to show uniform joints and allow to set until firm.
9. Clean excess mortar or adhesive from surface of tile with wet cheese cloth (not a sponge) while mortar is fresh.
10. Sound tile after setting. Replace hollow sounding tiles.

H. **Grouting**

1. Allow tiles to set amount of time recommended by mortar manufacturer before grouting.
2. Install in accordance with grout manufacturer's recommendations and ANSI A108.10.
3. Pack joints full and free before mortar takes initial set.
4. Clean excess mortar from surface with wet cheesecloth as work progresses. Do not use hydro-sponges.

3.3 **CLEANING**

- A. Clean excess mortar from surface with water as work progresses. Perform cleaning while mortar is fresh and before it hardens on surfaces.
- B. Sponge and wash tile diagonally across joints. Polish with clean dry cloth.
- C. Remove grout haze following recommendation of mortar additive manufacturer. Do not use acids for cleaning.

3.4 **PROTECTION**

- A. **Uncover tile work for Architect's inspection immediately upon completion and prior to covering up for protection from other trades for remainder of construction.**
- B. **Prohibit traffic from floor finish for 72 hours after installation.**
- C. Protect tile floors with heavy-duty, non-staining construction paper until Owner occupancy.

END OF SECTION

SECTION 095113

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 SECTION INCLUDES
 - A. **Suspended metal grid ceiling system with Tech Zone (or equal products) and perimeter trim.**
 - B. **Suspended metal grid ceiling system and perimeter trim.**
 - C. **Acoustical panels.**
- 1.3 SYSTEM DESCRIPTION
 - A. Suspension system to rigidly secure acoustical ceiling system including integral mechanical and electrical components with **maximum deflection of 1/360**.
- 1.4 QUALITY ASSURANCE
 - A. **Manufacturer:** Company specializing in manufacture of ceiling suspension system and ceiling tile with **10 years minimum experience**.
 - B. **Installer:** Company with **10 years minimum experience**.
 - C. Certificates
 - 1. Submit manufacturer's certification that suspension system is capable of supporting light fixtures, grilles, and other ceiling components.
- 1.5 SUBMITTALS
 - A. **Submit product data** under provisions of Section 013300.
 - B. Indicate on shop drawings, grid layout and related dimensioning, junctions with other work or ceiling finishes, interrelation of mechanical and electrical items related to system.
 - C. **Provide product data on metal grid system** components, acoustic units.
 - D. Submit samples under provisions of section 013300.
 - E. **Submit 2 samples, 6 by 6 inches in size, illustrating material and finish of each acoustic unit specified on this project.**
 - F. **Submit 1 sample, 12 inches long, of each type of suspension system main runner, cross runner, and edge trim specified in this project.**
 - G. Submit manufacturer's installation instructions under provisions of Section 013300.
- 1.6 ENVIRONMENTAL REQUIREMENTS
 - A. **Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after installation.**
- 1.7 DELIVERY, STORAGE AND HANDLING
 - A. Store tile and panel cartons open at each end to stabilize moisture content.
- 1.8 PROJECT CONDITIONS
 - A. **Do not install acoustical ceilings until building is enclosed, sufficient heat, air conditioning and relative humidity control equipment are operating, dust generating activities have terminated, and overhead work is completed, tested, and approved.**
 - B. Schedule installation of acoustic units after interior wet work is dry.
 - C. **Humidity: 20-40 percent** prior to, during, and after installation.
 - D. **Temperature: 61 degrees F minimum**, prior to, during, and after installation.

- 1.9 EXTRA STOCK
- A. **Provide 250 SF of primary acoustical panels and 100 SF of all other panels and an equivalent amount of ceiling grid material in extra stock under provisions of Section 017700.**
 - B. Store in designated location as directed by Owner.
- 1.10 COORDINATION
- A. Coordinate installation with other trades and make provisions for their work to prevent cutting and patching.
- 1.11 GUARANTEE
- A. The installation of the acoustical material shall be guaranteed to be tight and remain in place for **two years after final acceptance of the building**. Any loose or falling materials shall be replaced by Contractor at his own expense.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - SUSPENSION SYSTEM

- A. **Manufacturers:** Subject to compliance with requirements indicated, provide products of one of the following:
 - 1. Chicago Metallic.
 - 2. Donn /USG Metal Products.
 - 3. Armstrong World Industries.

2.2 SUSPENSION SYSTEM MATERIALS

- A. **Standard Exposed Tee Grid:**
 - 1. Intermediate duty system, complying with ASTM C 635, non-fire rated.
 - 2. Commercial quality cold-rolled steel with galvanized coating.
 - 3. All components die cut and interlocking.
 - 4. Exposed grid surface width: 9/16 inch and 15/16 inch systems. Refer to ceiling plans, finish plans and Section 008900 - Finish Selections Summary.
 - 5. Cope cross runners to lay flush with main runners, except at edge moldings.
 - 6. **Finish on exposed surfaces:** Baked-on white enamel, satin finish.
- E. **Grid Accessories:** Stabilizer bars, furring clips, splices, edge moldings, hold down clips and closure strips as necessary to complete and complement suspended ceiling grid system.
- F. All components die-cut and interlocking.
- G. **Support Channels and Hangers:** Galvanized steel; size and type to suit application, to rigidly secure acoustic ceiling system including integral mechanical and electrical components **with maximum deflection of 1/360**.

2.3 ACCEPTABLE MANUFACTURERS - ACOUSTIC UNITS

- A. Armstrong World Industries.
- B. Certainteed.
- C. U. S. Gypsum Company.

2.4 ACOUSTIC UNIT MATERIALS

- A. **Acceptable Products:**
 - 1. Refer to Section 008900.
 - 2. NRC rating of 0.9 minimum.

2.5 ACCESSORIES

- A. Hanger Wire: Minimum 12 gage, galvanized, self-annealed, mild steel wire.
- B. Touch-up Paint: Type and color to match acoustical and grid units.
- C. Hold Down Clips: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that existing conditions are ready to receive work.
- B. Verify that layout of hangers will not interfere with other work.
- C. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION - LAY-IN GRID SUSPENSION SYSTEM

- A. Install system in accordance with ASTM C636, manufacturer's instructions and as supplemented in this Section, to produce a ceiling true to lines and levels, free from warp and soiled or damaged grid or panels.
- B. Install system capable of supporting imposed loads to a deflection of 1/360 maximum.
- C. Install after major above ceiling work is complete. Coordinate the location of hangers with other work.
- D. Hang system independent of walls, columns, ducts, pipes and conduit. **Hang wires vertically and plumb directly from structure (not from fireproofing, fireproofing suspension members, bridging or roof decks). Locate first hanger 6 inches from wall and space 4'-0" along carrying channel.** Where carrying members are spliced, avoid visible displacement of face plane of adjacent members. **Do not splice main tees when width is less than 10'-0".**
- E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance. Construct trapeze hangers when necessary.
- F. Center system on room axis leaving equal border units, unless shown otherwise on the drawings. **Do not leave tiles less than 1/2 length or width in a given room.**
- G. Do not support fixtures or other components on main runners or cross runners if weight causes total dead load to exceed deflection capability. **Support fixture loads by supplementary hangers located within 6 inches of each corner; or support components independently.**
- H. Do not eccentrically load system, or produce rotation of runners.
- I. Install edge molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Miter corners. Provide edge moldings at junctions with other interruptions. Field rabbet panel edges. Where round obstructions occur, provide preformed closers to match edge molding. **Provide prefabricated radiused edge moldings around radiused wall corners and columns.** Use maximum lengths, straight, true to line, and level.
- J. Form expansion joints as detailed. Form to accommodate plus or minus one inch movement. Maintain visual closure.
- K. **Level grid with laser leveling device.**

3.3 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustic units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Lay directional patterned units one way with pattern parallel to shortest room axis. Fit border neatly against abutting surfaces.
- D. **Install units after above ceiling work is complete.**
- E. Install acoustic units level, in uniform plane, and free from twist, warp and dents.
- F. Cut panels to fit irregular grid and perimeter edge trim.
- G. **Lay acoustic insulation batts for a distance of 48 inches both sides of wall partitions unless entire ceiling is scheduled to receive acoustical batts.**
- H. **Install hold-down clips to retain panels tight to grid system within 10 feet of an exterior door.**

3.4 TOLERANCES

- A. Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Variation from Plumb of Grid Members Caused by Eccentric Loads: Two degrees maximum.

3.5 ADJUSTING AND PATCHING

- A. Replace damaged members of exposed suspension system. Replace ceiling board and tile that is damaged, installed improperly, or shows visible signs of sagging.

3.6 CLEANING

- A. Clean soiled areas of ceiling material with mild soap and water. Replace ceiling board and tile damaged by improper cleaning.

END OF SECTION

SECTION 095133

ACOUSTICAL METAL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:** Acoustical metal panels and associated suspension system for interior soffit under Grand Staircase and landings.

1.3 SUBMITTALS

- A. **Product Data:** For each type of product.
- B. **Shop Drawings:** Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Panel pattern.
 - 2. Ceiling suspension members.
 - 3. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 - 4. Ceiling perimeter and penetrations through ceiling; trim and moldings.
- C. **Samples for Verification:** For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:
 - 1. **Metal Panels:** Set of full-size Samples of each type, finish, color, pattern, and texture. Show panel edge profile.
 - 2. **Exposed Suspension-System Members, Moldings, and Trim:** Set of 6 inch long Samples of each type, finish, and color.

1.4 SYSTEM DESCRIPTION

- A. Suspension system to rigidly secure acoustical metal ceilings including integral mechanical and electrical components with **maximum deflection of 1/360**.

1.5 QUALITY ASSURANCE

- A. **Manufacturer:** Company specializing in manufacture of ceiling suspension system and ceilings with **10 years minimum experience**.
- B. **Installer:** Company with **3 years minimum successful experience**.
- C. Certificates
 - 1. Submit manufacturer's certification that suspension system is capable of supporting light fixtures, grilles, and other ceiling components.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical metal panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they are protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Handle acoustical metal panels, suspension-system components, and accessories carefully to avoid damaging units and finishes in any way.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **ACT-4 Basis of Design:** Refer to Section 008900 - Finish Selections Summary.

2.2 ACOUSTICAL METAL PANELS

- A. **Acoustical Panel Standard:** Provide manufacturer's standard pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- B. **Sheet Metal Characteristics:** For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.
 - 1. Aluminum Sheet: Rolled aluminum sheet, complying with ASTM B 209; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
 - a. **Painted Finishes:** Electrolytic zinc-coated steel complying with ASTM A 879, 13Z coating, surface treatment as recommended by finish manufacturer for type of use and finish indicated.
- C. **Sound-Absorbent Fabric Layer:** Provide fabric layer, sized to fit concealed surface of pan, and consisting of black, nonwoven, nonflammable, sound-absorbent material with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E 84.
 - 1. Bond fabric layer to panels in the factory with manufacturer's standard nonflammable adhesive.

2.3 ALUMINUM PANELS FOR ACOUSTICAL METAL PANEL CEILING

- A. **Classification:** Units complying with ASTM E 1264 for Type XX, other types described as perforated aluminum facing (pan) units with sound-absorbent fabric backing.
- B. **Panel Fabrication:** Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
 - 1. **Torsion-Spring Pans:** Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.
- C. **Panel Thickness:** Not less than 0.032 inch.
- D. **Panel Edge Detail:** Square with upturned edges.
- E. **Panel Joint Detail:** 1/8" W x 1/4" H, continuous reveals in same finish as panels.
- F. **Panel Size:** As indicated on Drawings.
- G. **Pan Face Finish:** Painted in custom color to match Architect's sample.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. **Metal Suspension System Standard:** Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.
- B. **Suspension Systems:** Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, torsion springs, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.
- C. **Attachment Devices:** Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.
 - 1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. **Wire Hangers, Braces, and Ties:** Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung, is less than yield stress of wire, but provide not less than 0.135 inch diameter wire.

- E. **Exposed Metal Edge Moldings and Trim:** Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units unless otherwise indicated.

- 1. For Circular Penetrations of Ceiling: Fabricate edge moldings to diameter required to fit penetration exactly.

2.5 **DIRECT-HUNG, STANDARD-GRID, METAL SUSPENSION SYSTEM FOR ACOUSTICAL METAL PAN CEILING**

- A. **Suspension System:** For torsion-spring-hinged pans.
- B. **Narrow-Face, Uncapped, Double-Web, Steel Suspension System:** Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytic zinc-coated or hot-dip galvanized, to produce structural members with 9/16 inch wide faces.
 - 1. **Structural Classification:** Intermediate-duty system.
 - 2. **Face Design:** With 1/4 inch wide reveals at all joints including perimeter edge joints.
 - 3. **Face Finish:** Painted to match color of metal pan.

2.6 **GENERAL FINISH REQUIREMENTS**

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 **ALUMINUM FINISHES**

- A. **Color-Coated Finish:** Manufacturer's standard of 2 coat fluorocarbon (Kynar) paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 **EXAMINATION**

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical metal pan ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical metal pan ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **PREPARATION**

- A. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and coordination drawings.

3.3 **INSTALLATION**

- A. General: Install acoustical metal pan ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and Cisca's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that do not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and hanger type involved. Install hangers in a manner that does not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Cut acoustical metal panel units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.
- G. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim. Comply with installation tolerances according to CISCA's "Metal Ceilings Technical Guidelines."
1. For lay-in, square-edge pans, install pans with edges fully hidden from view by flanges of suspension-system runners and moldings.
 2. For lay-in, reveal-edge pans on suspension-system runners, install pans with bottom of reveal in firm contact with top surface of runner flanges.
 3. For lay-in, reveal-edge pans on suspension-system members with box-shaped flanges, install pans with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.

4. **For torsion-spring-hinged pans**, position pans according to manufacturer's written instructions.
 5. For snap-in pans, fit adjoining units to form flush, tight joints.
 6. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
 7. Fit adjoining units to form flush, tight joints.
 8. Install directionally patterned or textured metal pans in directions indicated.
 9. Install sound-absorbent fabric layers in, and bond to, perforated metal pans.
 10. Install sound-absorbent pads in perforated metal pans[over metal spacer grids].
 - H. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules. Lay panels directly on ceiling system and close major openings to form complete coverage in required areas. Lay second sound-absorbent pads on sound attenuation panels.
 - I. Install hold-down clips where indicated.
- 3.4 CLEANING
- A. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings, after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, cleaning, and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage, including dented and bent units.
- 3.5 SCHEDULE
- A. Install torsion spring mounted panels and supporting grid at underside of all flights and landings of Grand Staircase in the east Atrium and floors 2, 3, and 4. Make provisions for recessed can lighting and sprinkler heads to occur in center bays of ceiling only. Refer to Drawings and Section 008900 - Finish Selection Summary.

END OF SECTION

SECTION 096513

RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:**
 - 1. **Resilient base.**
 - 2. **Reducer and transition strips.**

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable building code for flame/ fuel/smoke rating requirements in accordance with ASTM E 84.

1.4 SUBMITTALS

- A. **Provide manufacturer's product literature.**
- B. **Samples: Illustrate style, color, and size.**
 - 1. **Verification of Selection:**
 - a. **Quantity:** Two.
 - b. **Wall Base:** Submit 12 inch lengths.
 - c. **Trim Components:** Submit 12 inch lengths.
- C. Informational Submittals: Submit following upon request of the Architect:
 - 1. Certifications specified in Quality Assurance article.
 - a. Qualification Data: Manufacturer's and installer's qualification data.
 - b. Manufacturer's Instructions. Include applicable temperature range and special procedures.
- D. Submit cleaning and maintenance data under provisions of Section 017800.

1.5 QUALITY ASSURANCE

- A. **Single Source Responsibility:** Obtain each type and color of resilient products from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- B. **Installer Qualifications:** Acceptable to manufacturer with successful documented experience for **at least 10 years on a similar project size.**
- C. Regulatory Requirements: Comply with local regulations controlling use of volatile organic compounds for installation products.
- D. Certifications: Submit following upon request of the Architect:
 - 1. Manufacturer's certification that products furnished for project meet or exceed specified requirements.
 - 2. Manufacturer's certification attesting that Installer is trained and approved for application of materials.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 016000.
 - 1. Deliver materials to job site in manufacturer's unopened containers clearly marked with manufacturer's name, brand, size, thickness, grade, and color.
 - 2. Store materials in accordance with manufacturer's requirements.

1.7 **PROJECT CONDITIONS**

- A. Environmental Requirements: **Maintain minimum air and surface temperature required by adhesive manufacturer in spaces to receive products for at least 72 hours prior to installation, during installation, and for not less than 48 hours after installation.**
1. **Store products in spaces where they will be installed for at least 72 hours before beginning installation to achieve temperature stability.**
 2. Do not install products until they are at same air and surface temperature as space where they are to be installed.
 3. **After installation, maintain minimum air and surface temperature of 55 F in areas where work is completed.**

1.8 **MAINTENANCE**

- A. **Extra Materials:** Furnish in accordance with Section 017700.
1. Furnish resilient base for each color in quantity equal to **5 percent of total material furnished but not less than:**
 - a. **50 lineal feet of each type and color base installed.**
 - b. **6 outside molded corners matching base.**
 - c. **Provide in roll form of each different composition and color installed.**
 2. Store at job site where directed. Ensure boxes are identified by manufacturer, pattern, style, and color.

PART 2 - PRODUCTS

2.1 **MANUFACTURERS**

- A. **Acceptable Manufacturers:**
1. Burke Flooring.
 2. Roppe, Fostoria, OH.
 3. Johnsonite, Chagrin Falls, OH.
 4. Flexco, Tuscumbia, AL.
- B. Substitutions: Submit in accordance with Section.

2.2 **MATERIALS**

- A. **Resilient Base:**
1. ASTM F 1861.
 2. **Type: Rubber.**
 3. **Style: Straight with cove or angled toe bottom at all floors, per campus Design Guidelines.**
 4. Group: Solid/ homogenous.
 5. Thickness: 0.125 inch nominal.
 6. **Height: 4 inches nominal.**
 7. **Provide in roll form to accommodate installation with minimum seaming.**
 8. **Corner Units: Provide only factory manufactured inside and outside corners, matching base style and color. No exceptions. Color to match specified base color.**
 9. **Color/Manufacturer:** Final color and manufacturer to be selected by Architect from any of the listed manufacturers' full and complete lines. Refer Section 008900 and Finish Selection Summary.
- B. **Basis of Design:** As specified in Section 008900 - Design Selection Summary.

2.3 **RESILIENT FLOORING ACCESSORIES**

- A. **Carpet Reducer Strip:** Homogeneous vinyl or rubber composition.
1. **Profile:** Fabricate to accommodate 5/16-inch glue-down carpet and other adjacent applications as required. Submit for Architect's approval.
 2. **Width:** 2 inch, minimum.
 3. Align flush with top of carpet on side of strip.
 4. Tapered or bullnose edge on side opposite of carpet.

5. **Colors:** Selected by Architect from any of the following manufacturer's full range of colors.
 6. **Basis of Design:**
 - a. Super Imperial Reducer No. 705, Burke.
 - b. Deluxe Reducer Strip No. 78, by Flexco.
 - c. EG-XX-G Series, Johnsonite.
 - d. Carpet Reducer Strip No. 174, Roppe.
 - e. Johnsonite # CTA XX K
- B. **Carpet to carpet transition strip:**
1. **Basis of Design:**
 - a. Johnsonite # VT-XX-M6 or approved equal
- 2.4 **ACCESSORIES**
- A. Primers and Adhesives: Waterproof.
1. Materials required by resilient product manufacturer for particular product and substrate moisture content and condition.
 2. Removable adhesive with antimicrobial additive; approved by resilient product manufacturer.
 3. Volatile Organic Compound: 3 g/L, maximum.

PART 3 - EXECUTION

- 3.1 **EXAMINATION**
- A. Examine conditions and proceed with work in accordance with Section 014300.
1. Site Verification of Conditions: Verify that surfaces are free of substances which may adversely affect adhesive and resilient materials.
- 3.2 **PREPARATION**
- A. Prepare Substrate:
1. Remove ridges, bumps, trowel marks and protrusions from substrate.
 2. **Fill depressions, low spots, cracks, joints, holes, indentations, and other defects with self-leveling and patching compounds as required at no additional cost to Owner.**
 3. Clean substrate to remove paint, dirt, oil, grease, sealers, release agents, hardening compounds, curing compounds, residual adhesives, and harmful substances which could impair performance of adhesive materials used with resilient products.
 4. Vacuum clean substrate.
 5. Prime substrate in accordance with manufacturer's requirements.
 6. **Unroll rolled products minimum 24 hours before installation.**
- 3.3 **INSTALLATION**
- A. General: Comply with Section 016000.
1. Adhesive: Apply with notched trowel at rate and in pattern required by manufacturer.
 - a. Gun application is not permitted.
 - b. Apply to provide continuous bond between resilient material and substrate. Do not allow adhesive to bleed through joints.
 - c. Spread only enough adhesive to permit installation of materials before adhesive's initial set.
 - d. Allow solvent to flash off and adhesive to become tacky in accordance with manufacturer's requirements before applying resilient product.
 2. Scribing: Produce tight hairline joints.
 - a. Scribe to walls, columns, cabinets, floor outlets, floor penetrations, and other appurtenances.
 - b. Scribe, cut and fit exposed edges at adjoining construction and neatly abut.

- B. **Resilient Base:** Use longest lengths possible; **pieces less than 10 feet long are not permitted.** Seams are not permitted between wall corners spaced less than 10 feet apart.
 - 1. Fit joints straight, tight, and vertical.
 - 2. Install on solid substrate backing.
 - 3. Bond tight to wall and floor surfaces.
 - 4. Scribe to door frames and other interruptions.
 - 5. **Outside Corners: Use prefabricated outside corner units only.**
 - 6. **Inside Corners: Butt and cope, or mitered.**
 - a. **Do not wrap base around inside corners.**
 - 7. Align tops of adjacent sections.
- C. **Carpet Reducer Strips: Provide reducer strips at unprotected edges, exposed edges, and where carpet terminates.**
 - 1. Center strip under door where flooring terminates at door openings.
 - 2. Install in longest lengths practicable with minimal joints.
 - 3. Fit joints tightly.
 - 4. Secure resilient strips to subfloor by using adhesive.

3.4 CLEANING

- A. **Cleaning:** Clean in accordance with Section 017400.
 - 1. Immediately remove excess adhesive from surfaces without damage.
 - 2. Replace scuffed, scratched, broken, and discolored products.
 - 3. Re-install loose products.
 - 4. Clean surfaces in accordance with manufacturer's requirements. Do not use materials and methods which may damage finish and surrounding construction.

3.5 PROTECTION

- A. **Protect** in accordance with Section 015000.
 - 1. Protect work from damage from subsequent construction operations so there will be no indication of use and damage at time of acceptance.

END OF SECTION

SECTION 096516

RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. **Linoleum sheet floor covering** with heat welded seams.

1.3 SUBMITTALS

- A. **Product Data:** For each type of product indicated.
- B. **Shop Drawings:** For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. **Samples for Selection:** For each type of floor covering indicated.
- D. **Product Schedule:** For floor coverings. Use same designations indicated on Drawings.
- E. **Qualification Data:** For qualified Installer.
- F. **Maintenance Data:** For each type of floor covering to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation and seaming method indicated, and with ten years documented experience of successful similar installations.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor covering manufacturer for installation techniques required.
- B. **Mockups:** Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockups for floor coverings including resilient base and accessories.
 - a. Size: Minimum 100 sq. ft. for each type, color and pattern in locations directed by Architect.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

1.6 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive floor coverings during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 48 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Covering: Furnish quantity not less than 3% in roll form and in full roll width for each color, pattern, and type of floor covering installed.

PART 2 - PRODUCTS

2.1 VINYL SHEET FLOOR COVERING

- A. **Unbacked Vinyl Sheet Floor Covering:** ASTM F 1913, 0.080 inch thick.
- B. **Wearing Surface:** Smooth.
- C. **Sheet Width:** As standard with manufacturer .
- D. **Seaming Method:** Heat welded .
- E. **Colors and Patterns:** Refer to 00 89 00.

2.2 INSTALLATION MATERIALS

- A. **Trowelable Leveling and Patching Compounds:** Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. **Adhesives:** Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.
- C. **Seamless-Installation Accessories:**
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Color: Match floor covering.
- D. **Integral-Flash-Cove-Base Accessories:** Refer to 00 89 00.
 - 1. Cove Strip: 1-inch radius provided or approved by manufacturer.
 - 2. Cap Strip: Square metal, vinyl, or rubber cap provided or approved by manufacturer.
 - 3. Corners: Metal inside and outside corners and end stops provided or approved by manufacturer.
- E. **Floor Polish:** Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.**
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.**
- B. **Concrete Substrates:** Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- C. **Testing for Moisture in Floor Slabs:** Perform preinstallation testing specified by Section 090561 - Moisture Vapor Emission Control and provide MVE-control systems products for those floor surfaces that do not comply with requirements.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- E. Do not install floor coverings until they are same temperature as space where they are to be

installed.

1. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- F. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

3.3 FLOOR COVERING INSTALLATION

- A. **Comply with manufacturer's written instructions for installing floor coverings.**
- B. Unroll floor coverings and allow them to stabilize before cutting and fitting.
- C. Lay out floor coverings as follows:
1. Maintain uniformity of floor covering direction.
 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in floor covering substrates.
 3. Match edges of floor coverings for color shading at seams.
 4. Avoid cross seams.
- D. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
- E. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- F. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor coverings on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of floor coverings installed on covers and adjoining floor covering. Tightly adhere floor covering edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Seamless Installation:
1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and use welding bead to permanently fuse sections into a seamless floor covering. Prepare, weld, and finish seams to produce surfaces flush with adjoining floor covering surfaces.
- J. Integral-Flash-Cove Base: Cove floor coverings up vertical surfaces a dimension as indicated. Support floor coverings at horizontal and vertical junction by cove strip. Butt at top against cap strip.
1. Install metal corners at inside and outside corners.

3.4 CLEANING AND PROTECTION

- A. **Comply with manufacturer's written instructions for cleaning and protection of floor coverings.**
- B. Perform the following operations immediately after completing floor covering installation:
1. Remove adhesive and other blemishes from floor covering surfaces.
 2. Sweep and vacuum floor coverings thoroughly.
 3. Damp-mop floor coverings to remove marks and soil.
- C. Protect floor coverings from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor covering before applying liquid floor polish.
1. Apply two coat(s).
- E. Cover floor coverings until Substantial Completion.

END OF SECTION

SECTION 096519

RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Luxury Vinyl Tile and Planks (LVT).**

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable building code for flame/fuel/smoke rating requirements in accordance with ASTM E 84.

1.4 SUBMITTALS

- A. General: Submit in accordance with Section 007013 and Section 013100.
- B. **Product data:** For specified products, describing physical and performance characteristics, sizes, patterns and colors available.
- C. **Samples** under provisions of Section 013300.
 - 1. **Submit (2) samples** in full panel sizes for LVT, illustrating color and pattern for each floor material specified.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. **Store materials for 3 days prior to installation in area of installation to achieve temperature stability.**
- B. **Maintain ambient temperature required by adhesive manufacturer three days prior to, during, and 48 hours after installation of materials.**

1.6 QUALITY ASSURANCE

- A. **Single Source Responsibility:** Obtain each type and color of resilient products from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- B. **Installer Qualifications:** Acceptable to manufacturer with successful documented experience for **at least 10 years with a similar product.**
- C. **Regulatory Requirements:** Comply with local regulations controlling use of volatile organic compounds for installation products.
- D. **Certifications:** Submit following upon request of the Architect:
 - 1. Manufacturer's certification that products furnished for project meet or exceed specified requirements.
 - 2. Manufacturer's certification attesting that Installer is trained and approved for application of materials.
- E. **Mockups:** Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. **Build mockups for each floor tile pattern specified, including resilient base and accessories.**
 - a. **Size: 6 ft. x 6 ft. for each design and color scheme.**

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials in accordance with the requirements of Sections 016000.
- B. Store flooring materials in original containers in enclosed space at minimum of 70 degrees F for three days prior to installation.

1.8 **EXTRA MATERIALS**

- A. **Provide 50 square feet of extra stock flooring of each material and color specified under provisions of Section 017700.**

PART 2 - PRODUCTS

2.1 **MANUFACTURERS - RESILIENT TILE FLOORING**

- A. **Vinyl Planks: Refer to Section 008900 - Finish Selections Summary.**
B. Substitutions: Under provisions of Section 016000.

2.2 **TILE FLOORING MATERIALS**

- A. **Luxury Vinyl Tile and Plank Flooring (LVT):**
1. ASTM F 1700.
2. **Class:** As indicated by product designations.
3. **Type:** Type B, embossed surface.
4. **Thickness:** Refer to Finish Selection Summary Spreadsheet.
5. **Size:** Varies; Refer to Finishes Drawings and Finish Summary Spreadsheet.
6. **Acceptable Product: Refer to Section 008900 - Finish Selections Summary.**

2.3 **ACCESSORIES**

- A. **Subfloor Filler:** White premix latex; type recommended by flooring material manufacturer.
B. **Adhesives:** Waterproof; types recommended by flooring manufacturer.
C. **Vinyl Reducer:** Standard 1 inch wide tapered edging, 1/8 inch thick, color to match base.
D. **Subfloor Leveling Basis of Design:** Roppe; Subfloor Leveling Product.

PART 3 - EXECUTION

3.1 **EXAMINATION**

- A. Verify that surfaces are smooth and flat with maximum variation of 1/4 inch in 10 ft, and are ready to receive Work.
B. **Verify concrete floors are dry to a maximum moisture content of 7 percent (unless more stringent requirements are listed by the manufacturer, and exhibit negative alkalinity, carbonization, or dusting. Provide a copy of test results indicating this has been achieved to Architect prior to proceeding with the work.**
C. Examine concrete for sealers, hardeners or curing compounds not compatible with adhesive.
D. Beginning of installation means acceptance of existing substrate and site conditions.

3.2 **PREPARATION**

- A. **Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with subfloor filler as required at no additional cost to the Owner.**
B. Apply, trowel, and float filler to leave a smooth, flat, hard surface.
C. Prohibit traffic from area until filler is cured.

3.3 **INSTALLATION - LVT MATERIAL**

- A. Install in accordance with manufacturers' instructions.
B. Mix LVT from container to ensure shade variations are consistent.
C. Spread only enough adhesive to permit installation of materials before initial set.
D. Install LVT with all joints as called for in Finish Selection Summary Spreadsheet or as noted on drawings. Joints shall be tight butt joints, true to line.
E. **Do not lay LVT with less than 1/2 plank width adjacent to walls unless indicated on drawings. Confirm final position with Architect prior to installation.**
F. Terminate flooring at centerline of door openings where adjacent floor finish is dissimilar.
G. Install edge strips at unprotected or exposed edges, and where flooring terminates.
H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

- I. Install edge strips where indicated. Fit joints tightly.
- 3.4 CLEANING AND PROTECTION
 - A. **Comply with manufacturer's written instructions for cleaning and protection of floor tile.**
 - B. Prohibit traffic on floor finish for 24 hours after installation.
 - C. **Allow Architect to inspect tile flooring before covering up for protection from subsequent trades for the remainder of construction.**
 - D. Repair or replace damaged surfaces that are soiled or scarred prior to wax installation in a manner acceptable to Owner.
 - E. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
 - F. Protect floor tile products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - G. Cover flooring until Substantial Completion.

END OF SECTION

**SECTION 096566
RUBBER FLOORING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section

1.2 SUMMARY

- A. **Section Includes:** Adhered rubber tile flooring and accessories indicated, specified, or required for installation.

1.3 SUBMITTALS

- A. **Product Data:** Manufacturer's technical literature for each product indicated, specified, or required.
- B. **Maintenance Data:** For inclusion in maintenance manual required by Division 01.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed rubber flooring installations similar in material, design, and extent to that indicated for this Project, who is acceptable to manufacturer, and whose work has resulted in installations with a record of successful in-service performance.

1.5 PROJECT CONDITIONS

- A. Install products after other finishing operations, including painting, are completed.
- B. Maintain a temperature of not less than 70 deg F or more than 95 deg F in installation spaces for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless manufacturer's written recommendations specify longer time periods. After postinstallation period, maintain a temperature of not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during flooring installation and for time period after installation recommended in writing by manufacturer.

1.6 MAINTENANCE

- A. **Extra Materials:** Furnish not less than 5 percent of amount installed of each type, color, pattern, and size of tile flooring installed packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. **Basis of Design:** Refer to Section 008900 - Finish Selection Summary.

2.2 MATERIALS

- A. **Rubber Tile for Stair Treads:** A plain colored, rubber tile with a surface of classically round pastille raised studs at the tread and smooth rubber tile at the riser.

2.3 ACCESSORIES

- A. **Trowelable Leveling and Patching Compound:** Latex-modified, hydraulic-cement-based formulation approved by flooring manufacturer.
- B. **Adhesives:** Water-resistant type recommended by manufacturer to suit floor covering and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Acceptance of Surfaces and Conditions:

1. Examine substrates to receive rubber flooring and associated work for compliance with requirements and other conditions affecting performance.
2. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
3. Starting Work within a particular area will be construed as acceptance of surface conditions.

3.2 PREPARATION

A. Prepare substrates according to following:

1. Manufacturer's written instructions.
2. ASTM F 710.

B. Remove coatings, including curing compounds, sealers, hardeners, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer; do not use solvents.

C. **Testing for Moisture in Floor Slabs:** Perform preinstallation testing specified by Section 090561 - Moisture Vapor Emission Control and provide MVE-control systems products for those floor surfaces that do not comply with requirements.

D. Prepare substrates to comply with flatness tolerance of 1/4 in in 10 foot as follows:

1. Fill cracks, holes and depressions with trowelable leveling and patching compounds.
2. Remove concrete protrusions, bumps, and ridges by sanding or grinding.

E. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

F. Sweep and vacuum substrates to be covered by floor coverings immediately before installation.

3.3 INSTALLATION

A. Adhere products to substrates using a full spread of adhesive applied to substrate to comply with adhesive and flooring manufacturers' written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.

B. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

C. Restrict foot traffic at least 12 hours after installation. Restrict rolling traffic for 24 hours after installation. Do not clean floor for 5 days.

3.4 CLEANING

A. Perform the following operations immediately after installing flooring products:

1. Remove adhesive and other surface blemishes using cleaner recommended in writing by flooring manufacturer.
2. Sweep and vacuum floor thoroughly.
3. Do not wash floor until after waiting period recommended in writing by flooring manufacturer.
4. Damp mop floor to remove marks and soil using method and cleaner recommended in writing by flooring manufacturer.

3.5 PROTECTION

A. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended in writing by flooring manufacturer.

B. Do not move heavy or sharp objects directly over floor surfaces. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION

SECTION 096623

RESINOUS MATRIX TERRAZZO FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Thin-set, epoxy-resin terrazzo flooring and base.**
- B. **Precast epoxy-resin terrazzo units.**
- C. **Zinc divider strips.**

1.3 PREINSTALLATION MEETINGS

- A. **Preinstallation Conference:** Conduct conference at Project site.
 - 1. Review methods and procedures related to terrazzo including, but not limited to, the following:
 - a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - b. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - c. Review special terrazzo designs and patterns.

1.4 SUBMITTALS

- A. **Product Data:** For each type of product.
 - 1. Include terrazzo installation requirements.
- B. **Shop Drawings:** Provide electronic files of colored, computer generated plans showing the following:
 - 1. Terrazzo patterns in various colors.
 - 2. Divider strips.
 - 3. Control-joint strips.
 - 4. Accessory strips.
 - 5. Abrasive strips.
 - 6. Stair treads, risers, and landings.
 - 7. Precast terrazzo jointing and edge configurations.
- C. **Samples for Verification:** For each type, material, color, and pattern of terrazzo and accessory required showing the full range of color, texture, and pattern variations expected. Label each terrazzo sample to identify manufacturer's matrix color and aggregate types, sizes, and proportions. Prepare Samples of same thickness and from same material to be used for the Work, in size indicated below:
 - 1. **Terrazzo:** 12 inch square Samples.
 - 2. **Precast Terrazzo:** 12 inch square Samples.
 - 3. **Accessories:** 6 inch long Samples of each exposed strip item required.

1.5 CLOSEOUT SUBMITTALS

- A. **Maintenance Data:** For inclusion in maintenance manual required by Division 01.
 - 1. Include manufacturer's instructions for maintenance of installed Work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
 - 2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.6 QUALITY ASSURANCE

A. **Installer Qualifications:**

1. Engage an installer who is a contractor member of NTMA with a **minimum of 10 years' successful experience** installing specified products.
2. Engage an installer who is certified in writing by terrazzo manufacturer as qualified to install manufacturer's products.

B. **NTMA Standards:** Comply with NTMA's "Terrazzo Specifications and Design Guide" and with written recommendations for terrazzo type indicated unless more stringent requirements are specified.

C. **Mockups:** Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for terrazzo including accessories.
 - a. **Size: Minimum 2 steps.**
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in supplier's original wrappings and containers, labeled with source's or manufacturer's name, material or product brand name, and lot number if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting terrazzo installation.

B. Field Measurements: Verify actual dimensions of construction contiguous with precast terrazzo by field measurements before fabrication.

C. **Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.**

D. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.

E. Control and collect water and dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.

PART 2 - PRODUCTS

2.1 EPOXY-RESIN TERRAZZO

A. **Epoxy-Resin Terrazzo:** Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and aggregate proportions and mixing.

1. **Thickness:** 3/8 inch nominal.
2. **Formulated Mix Color and Pattern:** Match Architect's samples. Refer to Section 008900 - Finish Selection Summary and Finish Plans.

B. **Materials:**

1. **Flexible Reinforcing Membrane:** Manufacturer's resinous membrane for substrate-crack preparation and reflective-crack reduction.
 - a. Reinforcement: Fiberglass scrim.
2. **Primer:** Manufacturer's product recommended for substrate and use indicated.
3. **Epoxy-Resin Matrix:** Manufacturer's standard recommended for use indicated and in color required for mix indicated.
 - a. **Physical Properties without Aggregates:**
 - 1) **Hardness:** 60 to 85 per ASTM D 2240, Shore D.
 - 2) **Minimum Tensile Strength:** 3000 psi per ASTM D 638 for a 2 inch specimen made using a "C" die per ASTM D 412.

- 3) **Minimum Compressive Strength:** 10,000 psi per ASTM D 695, Specimen B cylinder.
- 4) **Chemical Resistance:** No deleterious effects by contaminants listed below after seven-day immersion at room temperature per ASTM D 1308.
 - a) Distilled water.
 - b) Mineral water.
 - c) Isopropanol.
 - d) Ethanol.
 - e) 0.025 percent detergent solution.
 - f) 1.0 percent soap solution.
 - g) 10 percent sodium hydroxide.
 - h) 10 percent hydrochloric acid.
 - i) 30 percent sulfuric acid.
 - j) 5 percent acetic acid.
- b. **Physical Properties with Aggregates:** For resin blended with Georgia white marble, ground, grouted, and cured per requirements in NTMA's "Terrazzo Specifications and Design Guide"; comply with the following:
 - 1) **Flammability:** Self-extinguishing, maximum extent of burning 1/4 inch per ASTM D 635.
 - 2) **Thermal Coefficient of Linear Expansion:** 0.0025 inch/inch per deg F for temperature range of minus 12 to plus 140 deg F per ASTM D 696.
4. **Aggregates:** Comply with NTMA gradation standards for mix indicated and contain no deleterious or foreign matter.
 - a. Abrasion and Impact Resistance: Less than 40 percent loss per ASTM C 131.
 - b. 24-Hour Absorption Rate: Less than 0.75 percent.
 - c. Dust Content: Less than 1.0 percent by weight.
5. **Finishing Grout:** Resin based.

2.2 PRECAST EPOXY-RESIN TERRAZZO BASE

- A. **Precast Terrazzo Base:** Minimum 3/4 inch thick, reinforced portland cement terrazzo units cast in maximum lengths possible, but not less than 10' sections. Comply with NTMA's written recommendations for fabricating precast terrazzo base units in sizes and profiles indicated.
 1. **Type:** Straight.
 2. **Top Edge:** Straight, with polished top surface.
 3. **Metal Toe Strip:** Zinc.
 4. **Outside Corner Units:** With finished returned edges at outside corner.
 5. **Color, Pattern, and Finish:** Match Architect's sample. Refer to Section 008900 - Finish Selection Summary.
- B. **Precast Terrazzo Units:** Comply with NTMA's written recommendations for fabricating precast terrazzo units in sizes and profiles indicated. Reinforce units as required by unit sizes, profiles, and thicknesses and as recommended by manufacturer. Finish exposed-to-view edges and reveals to match face finish. Ease exposed edges to 1/8 inch radius.
 1. Stair treads and landings.
 2. Color, Pattern, and Finish: Match Architect's control sample. Refer to Section 008900 - Finish Selection Summary.

2.3 STRIP MATERIALS

- A. **Thin-Set Divider Strips:** L-type angle by depth of terrazzo.
 1. **Material:** White-zinc alloy.
 2. **Top Width:** 1/32, 1/16, and 1/8 inch. Confirm final locations with Architect.
- B. **Control-Joint Strips:** Separate, double 1/32 inch L-type angles, positioned back to back, that match material and color of divider strips and in depth required for topping thickness indicated.
- C. **Accessory Strips:** Match divider-strip width, material, and color unless otherwise indicated. Use the following types of accessory strips as required to provide a complete installation:
 1. Base-bead strips for exposed top edge of terrazzo base.

2. Edge-bead strips for exposed edges of terrazzo.
3. Nosings for terrazzo stair treads and landings.
- D. **Abrasive Strips:** Three-line abrasive inserts at each nosing. Silicon carbide, aluminum oxide, or combination of both, in epoxy-resin binder set in channel.
 1. **Width:** 1/8 inch.
 2. **Depth:** As required by terrazzo thickness.
 3. **Length:** 4 inches less than stair width.
 4. **Color:** As selected by Architect from full range of industry colors.

2.4 MISCELLANEOUS ACCESSORIES

- A. **Strip Adhesive:** Epoxy-resin adhesive recommended by adhesive manufacturer for this use.
- B. **Anchoring Devices:**
 1. **Strips:** Provide mechanical anchoring devices or adhesives for strip materials as recommended by manufacturer and required for secure attachment to substrate.
 2. **Precast Terrazzo:** Provide mechanical anchoring devices as recommended by fabricator for proper anchorage and support of units for conditions of installation and support.
- C. **Patching and Fill Material:** Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
- D. **Joint Compound:** Terrazzo manufacturer's resinous product approved and recommended by manufacturer for application indicated.
- E. **Resinous Matrix Terrazzo Cleaner:** Chemically neutral cleaner with pH factor between 7 and 10 that is biodegradable, phosphate free, and recommended by sealer manufacturer for use on terrazzo type indicated.
- F. **Sealer:** Slip- and stain-resistant, penetrating-type sealer that is chemically neutral; does not affect terrazzo color or physical properties; is recommended by sealer manufacturer; and complies with NTMA's "Terrazzo Specifications and Design Guide" for terrazzo type indicated.
 1. **Surface Friction:** Not less than 0.6 according to ASTM D 2047.
 2. **Acid-Base Properties:** With pH factor between 7 and 10.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Acceptance of Surfaces and Conditions:
 1. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances, and other conditions affecting performance of the work.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.
 3. Starting work within a particular area will be construed as acceptance of surface conditions.

3.2 PREPARATION

- A. Clean substrates of substances, including oil, grease, and curing compounds, that might impair terrazzo bond. Provide clean, dry, and neutral substrate for terrazzo application.
- B. **Testing for Moisture in Floor Slabs:** Perform preinstallation testing specified by Section 090561 - Moisture Vapor Emission Control and provide MVE-control systems products for those floor surfaces that do not comply with requirements.
- C. **Preparing Concrete Slabs:**
 1. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with terrazzo.
 - a. **Shot-blast surfaces with an apparatus that abrades the concrete surface,** contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Repair damaged and deteriorated concrete according to terrazzo manufacturer's written recommendations.
 - c. Use patching and fill material to fill holes and depressions in substrates according to terrazzo manufacturer's written instructions.

- D. Protect other work from water and dust generated by grinding operations. Control water and dust to comply with environmental protection regulations.
 - 1. Erect and maintain temporary enclosures and other suitable methods to limit water damage and dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

3.3 EPOXY-RESIN TERRAZZO INSTALLATION

- A. Comply with NTMA's written recommendations for terrazzo and accessory installation.
- B. Place, rough grind, grout, cure grout, fine grind, and finish terrazzo according to manufacturer's written instructions and NTMA's "Terrazzo Specifications and Design Guide."
- C. **Installation Tolerance:** Limit variation in terrazzo surface from level to 1/8 inch in 10 feet; noncumulative.
- D. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
- E. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
- F. **Flexible Reinforcing Membrane:**
 - 1. Prepare and prefill substrate cracks with membrane material.
 - 2. Install membrane at substrate cracks in areas to receive terrazzo.
 - 3. Reinforce membrane with fiberglass scrim.
 - 4. Prepare membrane according to manufacturer's written instructions before applying substrate primer.
- G. **Primer:** Apply to terrazzo substrates according to manufacturer's written instructions.
- H. **Strip Materials:**
 - 1. **Divider and Control-Joint Strips:**
 - a. Locate divider strips in locations indicated.
 - b. Install control-joint strips back to back directly above concrete-slab control joints] [in locations indicated.
 - c. Install control-joint strips with 1/4 inch gap between strips, and install sealant in gap.
 - d. Install strips in adhesive setting bed without voids below strips, or mechanically anchor strips as required to attach strips to substrate, as recommended by strip manufacturer.
 - 2. **Accessory Strips:** Install as required to provide a complete installation.
 - 3. **Abrasive Strips:** Install with surface of abrasive strip positioned 1/16 inch higher than terrazzo surface.

3.4 PRECAST TERRAZZO INSTALLATION

- A. Install precast terrazzo units using method recommended by NTMA and manufacturer unless otherwise indicated.
- B. Do not install units that are chipped, cracked, discolored, or not properly finished.
- C. Seal joints between units with joint compound matching precast terrazzo matrix.

3.5 REPAIR

- A. Cut out and replace terrazzo areas that evidence lack of bond with substrate. Cut out terrazzo areas in panels defined by strips and replace to match adjacent terrazzo, or repair panels according to NTMA's written recommendations, as approved by Architect.

3.6 CLEANING AND PROTECTION

- A. **Cleaning:**
 - 1. Remove grinding dust from installation and adjacent areas.
 - 2. Wash surfaces with cleaner according to NTMA's written recommendations and manufacturer's written instructions; rinse surfaces with water and allow them to dry thoroughly.
- B. **Sealing:**
 - 1. Seal surfaces according to NTMA's written recommendations.

2. Apply sealer according to sealer manufacturer's written instructions.
- C. Protection: Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure that terrazzo is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 096813

TILE CARPETING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Direct glue-down carpet tiles.
2. Adhesive disc system for adhering carpet to substrate.
3. Carpet base with continuously bound top edge.

1.3 SUBMITTALS

- A. **Product Data:** For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation methods.
- B. **Sustainable Submittals:**
 1. Product data for adhesives, including printed statement of VOC content.
 2. Product data for carpet to comply with CRI Green Label program
 3. Product data for products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content
 4. Product certificates for products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
- C. **Shop Drawings:** Show the following:
 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 2. Carpet tile type, color, and dye lot.
 3. Pattern type, location, and direction.
 4. Transition details to other flooring materials.
- D. **Samples:** For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 1. **Carpet Tile:** Two (2) full-sized Samples or as required to indicate full range of variations in the pattern.
 2. **Adhesive Disks:** 2 each.
 3. **Pattern Mockups:** Provide 3 carpet tile mockups in the field consisting of 16 tiles each in 3 different patterns as requested by Architect. Tiles can be reused in final construction.
- E. **Maintenance Data:** For carpet tile to include in maintenance manuals specified in Division 1. Include the following:
 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.4 QUALITY ASSURANCE

- A. **Product Options:** Products and manufacturers named in Part 2 establish requirements for product quality in terms of appearance, construction, and performance. Other manufacturers'

products comparable in quality to named products and complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with CRI 104, Section 5, "Storage and Handling."

1.6 PROJECT CONDITIONS

- A. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity."
B. **Environmental Limitations:** Do not install carpet tile until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
C. Do not install carpet tile over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
D. Where demountable partitions or other items are indicated for installation on top of carpet tile, install carpet tile before installing these items.

1.7 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
B. **Special Carpet Tile Warranty:** Written warranty, signed by carpet tile manufacturer agreeing to replace carpet tile that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
1. **Warranty Period: 10 years from date of Substantial Completion.**

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. **Carpet Tile: Full-size units equal to 5 percent of amount installed** for each type indicated, but not less than 100 sq. yd.(8.3 sq. m).

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. **Acceptable Products:**
1. **Refer Section 008900.**
B. **Standard Carpet Tile:** Comply with ASTM D 6859-05 and ASTM D 1335-05.

2.2 INSTALLATION ACCESSORIES

- A. **Trowelable Leveling and Patching Compounds:** Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpet tile manufacturer.
B. **Adhesive Discs:** Pre-sized adhesive discs of type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and that is recommended by carpet tile manufacturer.
a. **Basis of Design:** Interface Tac Tiles; 3" x 3" adhesive squares or manufacturers' standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Verify that substrates and conditions are satisfactory for carpet tile installation and comply with requirements specified.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. **Use trowelable, self-leveling and patching compounds**, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
- C. **Testing for Moisture in Floor Slabs:** Perform preinstallation testing specified by Section 090561 - Moisture Vapor Emission Control and provide MVE-control systems products for those floor surfaces that do not comply with requirements.
- D. **Concrete Subfloors:** Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. **Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer. Provide results of tests and manufacturers requirements prior to carpet tile installation.**
 - 2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- E. Remove coatings, including curing compounds, and other substances that are incompatible with adhesive discs and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- F. **Broom and vacuum clean substrates** to be covered immediately before installing carpet tile. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules" and with carpet manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
 - 1. Install tile carpeting with adhesive discs in accordance with manufacturer's written instructions.
- C. **Cut and fit carpet tile to butt tightly to each other**, to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- F. **Install pattern parallel to walls and borders with all tiles oriented as indicated in Document 008900 - Finish Selection Summary and as indicated on Drawings. If pattern is not specified or shown on the Drawings, request clarification from Architect. No additional charges will be allowed based upon pattern selected by Architect.**

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 15, "Protection of Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION

SECTION 097200

WALL COVERINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Surface preparation, including floating gypsum board walls at concrete columns smooth, sizing of all surfaces, and prime painting.
 - 2. Vinyl wall coverings with printed graphics, including application materials and incidental services, on gypsum board wall surfaces in Atrium on North wall.

1.3 SUBMITTALS

- A. **Product Data** for each type of product specified. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.
- B. **Samples** for verification in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 - 1. **Wall Covering Material: Full-width sample, not less than 36 inches (914 mm) long**, from dye lot used for the Work.
 - a. Submit sample with specified treatments applied.
 - b. **Mark top and face of material.**
 - c. **Show complete pattern repeat.**
- C. Maintenance data for wall covering to include in the operation and maintenance manual specified in Division 1.

1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** Engage an installer who has a **minimum of 10 years' experience** on projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. **Fire-Test-Response Characteristics:** Provide wall coverings with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. **If specified products do not meet these specifications, bring to the attention of the Architect prior to purchasing specified materials.**
 - 1. **Flame Spread: 25 or less.**
 - 2. **Smoke Developed: 450 or less.**

1.5 PROJECT CONDITIONS

- A. **Space Enclosure and Environmental Limitations:** Do not install wall covering until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated until final occupancy.
- B. **Lighting:** Do not install wall covering until a lighting level of not less than **50 foot-candles** is provided on the surfaces to receive wall covering.
- C. **Ventilation:** Provide continuous ventilation during installation and for not less than the time recommended by the wall covering manufacturer for full drying or curing.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. **Rolls of Wall Covering Material:** Full-size rolls equal to 5 percent of amount of each type of wall covering installed.

PART 2 - PRODUCTS

2.1 VINYL WALLCOVERING

- A. **Vinyl:** Type I and II; in rolls from same production run.
- B. **Acceptable Products:**
 - 1. Refer to Section 008900 - Finish Selections Summary.
 - 2. Material Only Allowance: \$50.00 SF.
 - 3. Graphic design and electronic files will be provided by the Architect.

2.2 ACCESSORIES

- A. **Accessory Materials:**
 - 1. **Adhesive:** Mildew-resistant, non-staining adhesive, for use with specific wall covering and substrate application, as recommended by wall covering manufacturer.
 - 2. **Substrate Filler:** As recommended by adhesive and wall covering manufacturers; compatible with substrate.
 - 3. **Substrate Primer and Sealer:** Type as recommended by wall covering manufacturer.
 - 4. **Termination Trim:** Fry Reglet continuous reveal with friction fit grip.
- B. **Termination Trim:**
 - 1. **Corner Fabric / Vinyl Trim:** Gordon Interior Specialties; Model 966-FT-12.
 - 2. **Typical Center of Wall Fabric / Vinyl Tuck Reveal with Welt Insert:** Gordon Interior Specialties; Model 927-FR-12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for moisture content and other conditions affecting performance of Work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair wall covering's bond, including mold, mildew, oil, grease, incompatible primers, and dirt.
- C. Prepare substrates to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, and defects.
 - 1. **Painted Surfaces:** Treat areas susceptible to pigment bleeding.
 - 2. **Metals:** If not factory primed, clean and apply rust-inhibitive zinc primer.
 - 3. **Moisture Content:** Maximum of 5 percent on new plaster, drywall, concrete, and concrete masonry units when tested with an electronic moisture meter. Present findings to Architect prior to beginning installation.
 - 4. **Prime and size all new gypsum board** substrates with primer and sizing recommended by wall covering manufacturer.
- D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finishes with fine sandpaper.
- E. Acclimatize wall covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 INSTALLATION, GENERAL

- A. General: Comply with wall coverings manufacturers' written installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Cut wall covering panels in roll number sequence. Change run numbers at partition breaks and corners only.
- C. Install wall covering with no gaps or overlaps.
- D. Match pattern **72 inches(1830 mm)** above finish floor.
- E. Install seams vertical and plumb at least **6 inches(150 mm)** from outside corners and **3 inches(75 mm)** from inside corners. No horizontal seams.
- F. Remove air bubbles, wrinkles, blisters, and other defects.
- G. Trim edges for color uniformity, pattern match, and tight closure at seams and edges. Butt seams.
- H. Razor trim edges on flat work table. Do not razor cut directly on gypsum board substrate.
- I. Install wall covering termination trim at all locations where wall covering does not stop at an inside corner (whether or not indicated on Drawings).

3.4 CLEANING

- A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended by wall covering manufacturer.
- C. Replace strips that cannot be cleaned.

END OF SECTION

SECTION 097713

STRETCHED-FABRIC WALL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes:** Factory stretched-fabric wall panels

1.3 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.
- B. SAA: Sound Absorption Average.

1.4 SUBMITTALS

- A. **Product Data:** For each type of fabric facing, panel edge, core material, and mounting indicated.
- B. **Shop Drawings:** Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.
 - 1. **Include elevations showing panel sizes and direction of fabric weave and pattern matching.**
- C. **Samples:** For each type of fabric facing, including seams and corner conditions.
- D. **Coordination Drawings:** Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Electrical outlets, switches, and thermostats.
 - 2. Items penetrating or covered by stretched-fabric wall panels including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Alarms.
 - e. Sprinklers.
 - f. Access panels.
- E. **Maintenance Data:** For stretched-fabric wall panels to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal recommendations.

1.5 QUALITY ASSURANCE

- A. **Source Limitations:** Obtain stretched-fabric wall panels from single source from single manufacturer.
- B. **Fire-Test-Response Characteristics:** Provide stretched-fabric wall panels meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. **Surface-Burning Characteristics:** As determined by testing per ASTM E 84.
 - a. **Flame-Spread Index:** 25 or less.
 - b. **Smoke-Developed Index:** 450 or less.
 - 2. **Fire Growth Contribution:** Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and stretched-fabric wall panels manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.7 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not install stretched-fabric wall panels until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. **Lighting:** Do not install stretched-fabric wall panels until a permanent level of lighting is provided on surfaces to receive the units.
- C. **Air-Quality Limitations:** Protect stretched-fabric wall panels from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.
- D. **Field Measurements:** Verify locations of stretched-fabric wall panels and actual dimensions of openings and penetrations by field measurements before fabrication.

1.8 WARRANTY

- A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of stretched-fabric wall panels that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to the following:
 - a. Acoustical performance.
 - b. Fabric sagging, distorting, or releasing from panel edge.
 - c. Warping of core.
 - 2. **Warranty Period: Two years** from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. **Fabric: For each fabric, color, and pattern** installed, provide length equal to 10 percent of amount installed, but **no fewer than 10 yards**.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:**
 - 1. Manufacturer: Novawall Systems, Inc.
 - 2. Product: Novawall Factory Stretched Fabric Panel Systems.
- B. **Acceptable Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Armstrong.
 - 2. Barrisol USA.
 - 3. Conwed Designsapes.
 - 4. Fabric Wall.
 - 5. FabriTrack Systems, Inc.
 - 6. Novawall Systems, Inc.

2.2 STRETCHED-FABRIC WALL PANELS

- A. **Wall Panels:** Manufacturer's standard system consisting of facing material factory stretched tightly over a frame and core material and secured in the frame.

1. **Mounting:** Back mounted with manufacturer's standard, secured to substrate.
2. **Core:** Glass-fiber board.
3. **Edge Construction:** Manufacturer's standard chemically hardened core with no frame.
4. **Edge Profile:** **2 inch weltless with 1/4 inch reveal.** Confirm with Architect during submittal process.
5. **Corner Detail in Elevation:** Lapped square with continuous edge profile.
6. **Acoustical Performance:** Sound absorption NRC of not less than 0.95 according to ASTM C 423 for Type A mounting according to ASTM E 795.
7. **Nominal Overall Panel Thickness:** **2 inches.**
8. **Panel Width:** As indicated on Drawings.
9. **Panel Height:** As indicated on Drawings.
10. **Reveal:** Aluminum, 3/4 inch by 3/4 inch Fry Reglet, DRM-75-75, where indicated. Butt joints elsewhere.

2.3 MATERIALS

A. Core Materials:

1. **Glass-Fiber Board:** ASTM C 612, Type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft.96, unfaced, (unless otherwise indicated on Master Schedule) and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. **Fiberglass Face Layer:** 1/8-inch- thick layer of smooth sheet laminated to face of core.

B. Facing Material:

Fabric from same dye lot; color and pattern.

1. Refer Document 008900 - Finish Selections Summary.
2. Manufacturer, Product Line/Pattern, Style Number, Color: Refer to 008900.
 - a. **Provide COM material only allowance of \$40 per sq. yd.** Color and fabric to be selected by the Architect.

C. Frame Construction:

Manufacturer's standard, continuous, extruded plastic frame (track).

D. Mounting Devices:

Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

1. **Splines:** Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the unit, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.

2.4 FABRICATION

A. General:

Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

1. **Glass-Fiber Board Cores:** Chemically harden core edges and areas of core where mounting devices are attached.

B. Core-Face Layer:

Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

C. Facing Material:

Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. **Corners:** Square, 2 inch weltless type.
2. **Radius and Other Non-Square Corners:** Attach facing material so there are no seams or gathering of material.
3. **Fabrics with Directional or Repeating Patterns or Directional Weave:** Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Dimensional Tolerances of Finished Units:

Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabric, fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of stretched-fabric wall panels.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each area and establish layout of panels and joints of sizes indicated on Drawings within a given area.
- B. Before installation, allow fabric to adjust and become stable in spaces where it will be installed according to stretched-fabric system manufacturer's written instructions. **Acclimatize fabric for minimum of 24 hours** at ambient temperature and humidity conditions indicated for spaces when occupied for their intended use.

3.3 INSTALLATION

- A. Install panels in locations indicated. Unless otherwise indicated, install panels with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.
- C. Align fabric pattern and grain with adjacent panels.

3.4 INSTALLATION TOLERANCES

- A. **Variation from Plumb and Level:** Plus or minus 1/16 inch.
- B. **Variation of Panel Joints from Hairline:** Not more than 1/16 inch wide.

3.5 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

3.6 SCHEDULE

- A. Provide continuously around all interior walls of Dean's Conference Room from top of chairrail to bottom ceiling. Recess panels above chairrail so that finished face of panels are flush with adjacent drywall.

END OF SECTION

SECTION 097763

DIGITAL GRAPHICS WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

- 1. Custom wall coverings with digital graphics attached to wall with standoffs.

1.3 DESIGN INTENT

- A. Owner will provide digital image.

1.4 SUBMITTALS

- A. **Product Data** for each type of product specified.
- B. Maintenance data for wall covering to include in the operation and maintenance manual specified in Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design:

1. Wall Panels:

- a. Manufacturer: Koroseal Interior Products.
- b. Series: Digital Print Media.
- c. Panel Product: Acrylic.

2. Mounting Method:

- a. Manufacturer: Lumaline.
- b. Product: Flex-Display.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for moisture content and other conditions affecting performance of Work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.

3.3 INSTALLATION

- A. General: Comply with manufacturers' written installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

3.4 CLEANING

- A. Use cleaning methods recommended by manufacturer.

3.5 SCHEDULE

- A. South wall of Lobby 100A, south of monumental stair, size approximately 27'-9" x 19'-0".

END OF SECTION

SECTION 098316
ACOUSTIC PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.1 SUMMARY

- A. **Section Includes:** Spayed-applied acoustic plaster.

1.2 SUBMITTALS

- A. **Product Data:** For each type of product indicated.
- B. **Samples for Verification:** Furnish materials to be used with labels indicating colors, finish characteristics, and locations of the Work. Samples will be reviewed for color and appearance only. Furnish the following.
 - 1. 12" x 12" sample in color selected.
- C. **Acoustical Test Reports:** Provide acoustical test reports from an independent testing facility to verify test conditions and NRC rating.

1.3 QUALITY ASSURANCE

- A. **Installer Qualifications:** A firm or individual certified, licensed, or otherwise qualified by manufacturer with a **minimum of 10 years successful experience** installing specified product.

1.4 DELIVER, STORAGE, AND HANDLING

- A. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.
- B. Store materials inside, under cover, and aboveground; keep dry until ready for use. Remove from Project site and discard wet or deteriorated materials. Do not open packaging nor remove labels until time of installation.
- C. Protect materials from physical damage and from deterioration by moisture, soiling, and other sources. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. **Basis of Design:** International Cellulose Corp., SonaKrete Acoustical Finish System.

2.2 MATERIALS

- A. **Acoustic Plaster:** Cellulosic fiber.
 - 1. **Minimum NRC:** 0.75.
 - 2. **Color:** White.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. **Protection: Cover other work subject to damage from fallout or overspray of materials during application.**
- B. Clean substrates of substances that could impair bond of materials.

3.3 INSTALLATION

- A. General: Install system in accordance with manufacturer's printed installation instructions, submittals, applicable industry standards, and governing regulatory requirements for the Work.
- B. Spray and trowel in thin layers to achieve a total thickness of 3/4 inch.
- C. Cure material with continuous natural or mechanical ventilation.

3.4 CLEANING AND PROTECTION

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- B. Coordinate application of material with other construction to minimize need to cut or remove completed applications. As installation of other construction proceeds, inspect material and patch any damaged or removed areas.
- C. Protect the Work so it will not deteriorate or be damaged.

END OF SECTION

SECTION 099100

PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Complete interior and exterior surface preparation and finishing for field application of latex and oil based coatings.**
- B. **Requirements for field finishing mechanical and electrical equipment.**
- C. Examine specifications for various other trades and their provisions regarding their painting. **Paint or finish surfaces that are left unfinished by other sections of specifications as a part of this Section.**
- D. **Sizing of all interior walls prior to applying painted finish.**

1.3 SURFACES NOT TO RECEIVE FIELD FINISHING

- A. Do not paint copper, bronze, chrome plated items, nickel, stainless steel, Monel metal, lead, face brick, prefinished wall and floor coverings, items with factory applied final finish (except where exposed on roofs and in finished spaces), chases, and plenums unless otherwise specified or scheduled.

1.4 QUALITY ASSURANCE

- A. **Applicator:** Company specializing in commercial painting and finishing with **minimum 10 years experience.**
- B. **Product Labels:** Include manufacturer's name, type of paint, stock number, color, and label analysis on label of containers.
- C. **Pre-Installation Conference:** Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to painting including, but not limited to, the following:
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review required certifying procedures.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable building code for flame spread/fuel contribution/smoke development rating requirements for finishes.
- B. Comply with applicable city, county, state, and federal requirements and ordinances regarding maximum Volatile Organic Compound (VOC) content of coatings.
 - 1. **Provide paints and coatings for interior applications with zero-VOC content, unless otherwise approved by Architect.**

1.6 SUBMITTALS

- A. **Submit product data and samples** under provisions of Section 013300.
- B. Provide product data describing physical performance criteria and composition on finishing products.
- C. **Submit color selection samples** under provisions of Section 013300.
- D. **Submit two (2) samples, 16 by 16 inches in size,** illustrating range of colors, paint types, and textures selected for each surface finishing product scheduled.

- 1.7 FIELD SAMPLES
- A. Provide field samples under provisions of Section 014000.
 - B. **Provide field sample panel, 8 ft long by 8 ft wide, illustrating each coating color, paint type, texture, and finish intended for use. Obtain Architect's approval prior to purchasing remainder of materials.**
 - C. Locate as directed by Architect.
 - D. Accepted sample may remain as part of the Work.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site under provisions of Section 016000.
 - B. Store and protect products under provisions of Section 016000.
 - C. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
 - D. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.
 - E. Store paint materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in well ventilated area, unless required otherwise by manufacturer's instructions.
 - F. Take precautionary measures to prevent fire hazards and spontaneous combustion.
- 1.9 ENVIRONMENTAL REQUIREMENTS
- A. Do not apply materials when surface and ambient temperatures are outside the ranges required by paint manufacturer.
 - B. **Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 degrees F for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.**
 - C. **Do not apply exterior coatings during rain or snow, or when relative humidity is above 75 percent,** unless allowed otherwise by manufacturer's instructions.
 - D. **Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior;** unless allowed otherwise by manufacturer's instructions.
 - E. **Minimum Application Temperature for Varnish and Finishes: 65 degrees F for interior or exterior,** unless required otherwise by manufacturer's instructions.
 - F. **Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.**
- 1.10 EXTRA STOCK
- A. **Provide (2) unopened gallon containers of each color to Owner as extra stock.**
 - B. Label each container with color, color number, texture, and room locations, in addition to the manufacturer's label.
 - C. Furnish under provisions of Section 017700.
- 1.11 SCAFFOLDS AND PROTECTION
- A. Provide adequate safe ladders, scaffolds, and stages necessary to complete work.
 - B. Protect completed finish and paint work, and protect adjacent finish surfaces from paint splatter, spills and stains. Use adequate drop cloths and masking procedures during progress of work.
- 1.12 PRECAUTIONS
- A. Do not store paints, oils, thinners, and other flammable items inside building. Store in approved containers when not in actual use during painting job. Keep fire hazard at a minimum.
 - B. Take precaution to protect public and construction workers during progress of work.
 - C. Furnish temporary fire extinguisher of suitable chemicals and capacity. Locate near flammable materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Sherwin-Williams (listed as standard of quality in schedule).
- B. Glidden Professional.
- C. Kelly Moore
- D. P.P.G. Industries.
- E. **Provide materials selected for coating systems for each type surface from a single manufacturer** unless otherwise specified. Secondary products such as linseed oil, turpentine, and shellacs shall be first quality products of a reputable manufacturer.

2.2 MATERIALS

- A. Coatings: Ready mixed. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating with good flow and brushing properties; capable of drying or curing free of streaks or sags.
- B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners, and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- C. Patching Materials: Latex filler.

2.3 FINISHES

- A. Refer to schedule at end of section.
- B. **Colors and Sheens:** Refer to Document 008900 - Finish Selection Summary and Finish Selection Spreadsheet.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and substrate conditions are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report to General Contractor any condition that may potentially affect proper application.
- C. Test shop applied primers for compatibility with subsequent cover materials.
- D. Beginning of installation means acceptance of existing surfaces and substrate.

3.2 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces or finishing.
- B. Correct minor defects and clean surfaces which affect work of this Section. Remove existing coatings which exhibit loose surface defects.
- C. Shellac and seal marks which may bleed through surface finishes.
- D. **Impervious Surfaces:** Remove mildew by scrubbing with solution of tri-sodium phosphate (TRS) and bleach. Rinse with clean water and allow surface to dry.
- E. **Gypsum Board Surfaces:** Latex fill minor defects. Spot prime defects after repair. **Size all gypsum board walls (similar to wall covering sizing) prior to priming wall surface.**
- F. **Galvanized Surfaces:** Remove surface contamination and oils and wash with solvent. **Apply coat of etching primer.**
- G. **Uncoated Steel and Iron Surfaces:** Remove grease, scale, dirt, and rust. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting; clean by washing with solvent.
- H. **Shop Primed Steel Surfaces:** Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- I. **Aluminum Substrates:** Remove loose surface oxidation.

- J. **Interior Wood Items Scheduled to Receive Clear Finish:** Wipe off dust and grit prior to sealing. Fill nail holes and cracks prior to sealing; sand between coats.
 - K. **Interior Wood Items Scheduled to Receive Paint Finish:** Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.
 - L. **Exterior Wood or Cementitious Board Scheduled to receive Paint Finish:** Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections.
 - M. **Shop Finished Items:** Finish in accordance with AWI standards and guide lines.
 - N. **Interior Metal Doors and Frames Scheduled for Painting:** Seal top and bottom edges with primer.
- 3.3 PROTECTION
- A. Protect elements surrounding work of this Section from damage or disfiguration.
 - B. Repair damage to other surfaces caused by work of this Section.
 - C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
 - D. Remove empty paint containers from site.
- 3.4 APPLICATION
- A. **The intent of these Specifications is to produce the highest quality appearance of paint and finish surfaces. Finish walls to Level 4 finish at a minimum and Level 5 finish where scheduled. Employ skilled mechanics and painters only. The proper preparation of surfaces will be strictly enforced and wherever finished surfaces show any defects due to improper preparation, workmanship, etc., remove defects and refinish work at Contractor's expense. Long corridors to receive Level 4 finish with light orange peel texture. Ceiling to receive Level 4 finish with no texture. Office spaces to receive Level 3 finish with light orange peel texture.**
 - B. Apply products in accordance with manufacturer's instructions. Final finish coats shall have visual evidence of solid hiding and uniform appearance, and shall **be free and smooth of brush marks, streaks, sags, runs, laps, or skipped areas.**
 - C. **All metal doors and frames shall be spray painted, not brushed. No exceptions!**
 - D. Do not apply finishes to surfaces that are not dry.
 - E. Apply each coat to uniform finish and thickness.
 - F. Sand lightly between coats on wood and metal items to achieve required finish.
 - G. Allow applied coat to dry before next coat is applied.
 - H. **Prime back surfaces of interior and exterior woodwork** (including roof fascia) where applicable scheduled to be painted with primer paint.
 - I. **Prime back surfaces of interior woodwork scheduled to receive stain or varnish** finish with gloss varnish reduced 25 percent with mineral spirits.
 - J. Edges of paint adjoining other materials or colors shall be sharp and clean with no overlapping.
- 3.5 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT
- A. **Paint shop primed equipment. Paint shop prefinished items where exposed to view in finished spaces.** In mechanical rooms, repair shop pre-finished coatings which have been scratched or otherwise damaged with identical touch-up paint. Sand prior to touching up as required.
 - B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and spray paint separately.
 - C. Paint grilles, registers, and diffusers to match adjacent wall and ceiling surfaces, except that factory pre-finished items need not be painted.
 - D. **In finished spaces exposed to view, prime and paint all exposed structure. pipes, conduit, boxes, ducts, hangers, brackets, collars, and supports, whether or not indicated on Drawings. Verify colors with Architect.**
 - E. Repair or replace identification markings on mechanical or electrical equipment when painted accidentally.

- F. **Paint surfaces of plywood backboards for electrical and telephone equipment** before installing equipment whether or not called for on Drawings.
 - G. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.
 - H. **Paint exposed air handlers, roof ventilators, goose necks, exhaust fans, and other items on roof with 2 coats (or as otherwise required to cover) exterior oil-based enamel. Prepare surfaces in accordance with base metal or primer as specified herein.**
- 3.6 CLEANING/TOUCH-UP
- A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
 - B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.
 - C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
 - D. **Spot painting will be allowed** to correct soiled or damaged paint surfaces **only when touch-up spot** will blend into surrounding finish and **is invisible to normal viewing** (as determined by the Architect). **Otherwise, re-coat entire section to corners, wall break, or visible stopping point.**
- 3.7 VOLATILE ORGANIC COMPOUND (VOC) COMPLIANCE
- A. Products listed in following schedule or substitutes proposed for use must be formulated to meet applicable ordinances and regulations regarding maximum VOC content. Utilize products which have been specially formulated to meet such requirements.
- 3.8 **SCHEDULE (Note: All of the following conditions may not exist on this project). Sherwin-Williams products are listed as "Basis of Design".)**
- A. **Interior Gypsum Wallboard:**
 - 1. **Taping and Bedding** - All gypsum wallboard joints and corner angles are to be taped, pre-bedded, and finished with at least 2 floats. All screws and/or nails will be filled at least 3 times. All rough edges are to be sanded smooth. Any blisters or imperfections in tape will be cut out and repaired.
 - 2. **Texture:**
 - a. **Walls: Light sprayed on orange peel texture.**
 - b. **Ceilings: No texture.**
 - 3. **Level of Finish:** ~~Finish all gypsum wallboard wall to a minimum Level 4 finish and gypsum drywall ceilings to Level 5 finish typical, unless noted otherwise. Long corridors to receive Level 4 finish with light orange peel texture. Ceiling to receive Level 4 finish with no texture. Office spaces to receive Level 3 finish with light orange peel texture.~~
 - 4. **Priming** - All gypsum wallboard shall be sized with a wall covering sizing product and then primed with Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600.
 - 5. **Topcoats** – 2 coats Sherwin-Williams ProMar 200 Zero VOC Interior Latex Eg-shel, B20-2600 Series.
 - 6. Use flat for all ceilings, Sherwin-Williams ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series.
 - 7. Finish colors as selected by Architect from manufacturer's full line of colors, including primary custom colors.
 - 8. **Dry Erase Finish:** Sherwin-Williams Dry Erase, Clear Gloss Coating, KB65C2000 Kit. *Surfaces to receive dry erase paint to receive minimum Level 4 finish.*
 - 9. **Epoxy:** Sherwin-Williams Pre-Catalyzed Waterbased Epoxy, K45-150 Series, Eg-Shel.
 - B. **Interior Painted Metal Trim:**
 - 1. **Preparation - Previously painted metal:** Surface will be sanded to ensure adhesion. Loose or peeling paint will be scaled and sanded smooth. **New metal:** All dust, dirt, and grease will be cleaned from surface.
 - 2. **Priming** - All unprimed metal will be primed with Sherwin-Williams Pro-Cryl Universal Water Based Metal Primer, B66-310 Series.

3. **Topcoats** - 2 coats Sherwin-Williams ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series.
 4. Finish colors as selected by Architect from manufacturer's full line of colors, including custom colors.
- C. **Interior Concrete Masonry Units: (Not Used)**
1. **Preparation** - Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions..
 2. **Block Filler** - Sherwin-Williams PrepRite Block Filler, B25W25.
 3. **Topcoats** - 2 coats Sherwin-Williams ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series.
Wet Areas Topcoats – 2 coats Sherwin-Williams Pro Industrial Water Based Catalyzed Epoxy Gloss, B73-300 Series.
 4. Finish colors as selected by Architect from manufacturer's full line of colors, including primary and custom colors.
- D. **Exterior Metal Surfaces:**
1. **Preparation - On new metal surfaces:** Clean surface to remove any foreign matter such as dirt or grease. Etching may be required on some metal surfaces.
 2. **Priming** - On new metal surfaces: Apply Sherwin-Williams Pro-Cryl Universal Water Based Metal Primer, B66-310 Series, (depending on type and condition of metal). Lightly sand any rash or roughness.
 3. **Topcoats-** On new primed metal surfaces: 2 topcoats of Sherwin-Williams Pro Industrial Acrylic Eg-Shel, B66-660 Series. Finish colors will be selected by Architect. Refer to Document 008900 - Finish Selections Summary.
 4. Finish colors as selected by Architect from manufacturer's full line of colors, including primary and custom colors.
- E. **Exterior Painted Wood Surfaces:**
1. **Priming** - On new wood surfaces: Apply Sherwin-Williams Exterior Latex Wood Primer, B42W8041.
 2. **Topcoats-** On new primed wood surfaces: 2 topcoats of Sherwin-Williams A-100 Exterior Latex Flat, A6-100 Series. Finish colors will be selected by Architect.
 3. Finish colors as selected by Architect from manufacturer's full line of colors, including primary and custom colors.
- F. **Exterior Painted Concrete Surfaces:**
1. **Priming** - On new concrete surfaces: Apply Sherwin-Williams Loxon Interior/Exterior Acrylic Masonry Primer, A24W8300.
 2. **Topcoats-** On new primed concrete surfaces: 2 topcoats of Sherwin-Williams A-100 Exterior Latex Flat, A6-100 Series. Finish colors will be selected by Architect.
 3. Finish colors as selected by Architect from manufacturer's full line of colors, including primary and custom colors.
- G. **Exterior Stained/Clear Wood Surfaces:**
1. Two coats Sherwin-Williams SD3T15, SuperDeck Exterior Semi-Transparent Stain.
OR
 2. Two coats Sherwin-Williams SD1T100, SuperDeck Exterior Waterborne Clear Sealer.
OR
 3. Two coats Sherwin-Williams SD7-Series, SuperDeck Exterior Waterborne Solid Color Stain.

END OF SECTION

SECTION 099713

STEEL COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. Surface preparation and high build glazed coatings with polyurethane topcoats for selected interior ferrous metal surfaces.
- 2. Surface preparation and epoxy coatings for exterior metal surfaces, such as architectural metals and railings and other metal surfaces as called for in the Documents.

1.3 QUALITY ASSURANCE

- A. **Manufacturer:** Company specializing in manufacturing quality epoxy and polyurethane coatings **with 10 years minimum experience** manufacturing specified products.
- B. **Applicator:** Company specializing in commercial painting and finishing **with minimum 10 years documented experience** applying specified products.
- C. **Product Labels:** Include manufacturer's name, type of paint, stock number, color and label analysis on label of containers.
- D. **Single Source Responsibility:** Materials selected for coating systems for each type surface shall be product of a single manufacturer unless otherwise specified.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable building code for flame/fuel/smoke rating requirements for finishes.

1.5 TESTS

- A. Provide periodic testing with Wet Film Thickness gage to verify that proper thickness of finish coatings are being applied.

1.6 SUBMITTALS

- A. Submit product data under provisions of Section 013300.
- B. **Provide product data** on all finishing products.
- C. **Submit color selection samples** under provisions of Section 013300.
- D. Submit 2 samples, 16 by 16 inches in size illustrating scheduled colors and textures for each surface finishing product scheduled.
- E. Submit manufacturer's application instructions under provisions of Section 013300.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 016000.
- B. Store and protect products under provisions of Section 016000.
- C. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
- D. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.
- E. Store paint materials at minimum ambient temperature of 50 degrees F and a maximum of 90 degrees F, in well ventilated area, unless required otherwise by manufacturer's instructions.

- F. Take precautionary measures to prevent fire hazards and spontaneous combustion.
- 1.8 ENVIRONMENTAL REQUIREMENTS
- A. **Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 50 degrees F for 24 hours before, during, and 48 hours after application of finishes**, unless required otherwise by manufacturer's instructions.
 - B. **Minimum Application Temperatures:** 50 degrees F; unless required otherwise by manufacturer's instructions.
 - C. Provide lighting level of 80 foot candles measured mid- height at substrate surface.
 - D. Restrict traffic from area where coating is being applied or is curing.
- 1.9 EXTRA STOCK
- A. Provide in accordance with Section 017700.
 - B. **Provide a (1) unopened gallon container of each color to Owner's Representative as extra stock.**
 - C. Label each container with color, color number, texture, and room locations, in addition to the manufacturer's label.
- 1.10 PRECAUTIONS
- A. Fire Extinguishers: Provide temporary fire extinguisher of suitable chemicals and capacity, located near the flammable materials as described.
- 1.11 WARRANTY
- A. **Provide 3 year warranty** under provisions of Section 017800.
 - B. Warranty: Include coverage for bond to substrate and degradation of chemical resistance.

PART 2- PRODUCTS

- 2.1 MANUFACTURERS
- A. **Acceptable Manufacturers:** Subject to compliance with requirements herein, provide products from one of the following:
 - 1. **Basis of Design:** Tnemec Company, Inc.
 - 2. Carboline.
 - 3. Sherwin Williams.
 - B. Substitutions: Under provisions of Section 016000.
 - C. Products specified in Schedule are those of Tnemec Company, Inc. as a standard of quality.
- 2.2 MATERIALS
- A. Coatings:
 - 1. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
 - 2. Good flow and brushing properties; capable of drying or curing free of streaks or sags.
 - B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- 2.3 PRIMERS
- A. **Type P1 – Metal Primer for all interior and exterior applications**
 - B. **Acceptable Manufacturers and Products**
 - a. **Basis of Design:** Series 161 Tnemec-Fascure.
 - b. Carboline 893 Epoxy Primer by Carboline.
 - c. 7500 Magna-Prime by International.
 - 2. **Physical Requirements:**
 - a. **Solids Content:** 58 percent minimum.

- b. **VOC:** 3.5 pounds per gallon maximum.
- 3. **Performance Requirements:**
 - a. General: Tests are based on one coat at manufacturer's recommended DFT.
 - b. **Adhesion:** ASTM D 4541, not less than 900 psi pull, average of five trials.
 - c. **Salt Spray (Fog):** ASTM B 117, no blistering, cracking, softening, or delamination of film. No more than 1/32 inch rust creepage at scribe after 1500 hours exposure.

2.4 EPOXY COATINGS

A. **Type E1 – Epoxy Coatings for interior applications only – Second Coat**

- 1. **Acceptable Manufacturers and Products:**
 - a. **Basis of Design:** Series 66 Hi Build Epoxoline by Tnemec.
 - b. 190 HB by Carboline.
 - c. Magna Coat 7510 by International.
- 2. **Physical Requirements:**
 - a. Solids content by volume: 54 percent minimum.
 - b. Sheen: Semi-gloss.
 - c. V.O.C.: 3.08 pounds per gallon.
- 3. **Performance Requirements:**
 - a. General: Tests are based on 2 coats at manufacturer's recommended DFT.
 - b. Abrasion: ASTM D 4060, CS17 wheel with 1000 g load, maximum 130 mg loss after 1000 cycles.
 - c. Adhesion: ASTM D 4541, not less than 900 psi pull, average of 3 trials.
 - d. Humidity: ASTM D 4585, no blistering, cracking, softening, and delamination of film. No more than 1/32 inch rust creepage at scribe and no more than one percent rusting at edges after 1000 hours exposure.
 - e. Salt spray (Fog): ASTM B 177, No blistering, cracking, softening, and delamination of film. No more than 1/32 inch rust creepage at scribe and no more than one percent rusting at edges after 1000 hours exposure.

2.5 POLYURETHANE COATINGS

A. **Type U1 - High Build Acrylic Polyurethane Coatings for exterior applications only – Second and Third Coat:**

- 1. **Acceptable Manufacturers and Products:**
 - a. **Basis of Design:** Series 73 Endura-Shield, semi-gloss, by Tnemec.
 - b. 134 HS, gloss, by Carboline.
 - c. Hythane Ultra 8731, gloss, by International.
- 2. **Physical Requirements:**
 - a. Solids content by volume: 57 percent minimum.
 - b. Sheen: Semi-gloss.
 - c. VOC: 3.5 pounds per gallon.
- 3. **Performance Requirements:**
 - a. General: Tests are based on one coat of primer and one finish coat at manufacturer's recommended DFT.
 - b. Abrasion: ASTM D 4060, CS17 wheel with 1000 g load, maximum 90 mg loss after 1000 cycles.
 - c. Adhesion: ASTM D 4541, not less than 800 psi pull, average of 3 trials.
 - d. Humidity: ASTM D 4585, no blistering, cracking, and delamination of film after 1000 hours exposure.
 - e. Salt spray (Fog): ASTM B 117, No blistering, cracking, softening, and delamination of film. No more than 1/8 inch rust creepage at scribe and no more than one percent rusting at edges after 1000 hours exposure.

B. **Type U2 – Aliphatic Polyester Polyurethane Coatings – Third and final coat for interior applications only**

1. **Acceptable Manufacturers and Products:**
 - a. **Basis of Design:** Series 290 CRU semi-gloss, by Tnemec.
 - b. 450HS, by PPG Protective & Marine Coatings, Amercoat.
 - c. Carbothane 133 Series, by Carboline.
2. **Physical Requirements:**
 - a. Solids content by volume: 67 percent minimum.
 - b. Sheen: Semi-gloss.
 - c. VOC: 2.41 pounds per gallon.

2.6 COATING SYSTEMS

- A. Refer to schedule at end of Section.

PART 3- EXECUTION

3.1 INSPECTION

- A. Verify that surfaces and substrate conditions are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report to Owner's Representative any condition that may potentially affect proper application.
- C. Beginning of installation means acceptance of existing surfaces and substrate.

3.2 SURFACE PREPARATION - GENERAL

- A. Protect surrounding and adjacent surfaces in manner recommended by coating manufacturer.
- B. Remove oil, wax and grease by scraping off heavy deposits and cleaning with mineral spirits or hot trisodium phosphate solution followed by water rinse.

3.3 SURFACE PREPARATION - SPECIFIC

A. Steel

1. Exterior/Interior Exposed Steel items Scheduled to Receive SC-1:

- a. Surface prepared in accordance with SSPC-SP3 Power Tool Clean cleaning procedures.
- b. Shop primed steel scheduled to receive SP-1: Field touched-up prior to painting.
- c. Unprimed steel: Minimum surface preparation in accordance with SSPC-SP3 Power Tool Clean.

B. Non-ferrous Surfaces

1. Exterior/Interior Non-ferrous Metal Surfaces Scheduled to Receive SC-1 and SC-3:

- a. Minimum surface preparation in accordance with SSPC-SP1 Solvent Clean procedures.
- b. Remove white rust from galvanized.
- c. Utilize SSPC-SP10 on high temperature surfaces.

3.4 SURFACE PREPARATION FOR NEW WORK

A. General:

1. Correct minor defects.
2. Remove temporary labels, wrappings, and protective coverings from surfaces to be coated.
3. Seal stains, marks, and other imperfections which may bleed through surface finishes.

B. Steel - Unprimed:

1. Remove weld spatter by chipping or grinding.
2. Clean interior and weather protected steel in accordance with SSPC SP7, "Brush-Off Blast Cleaning".

3. Apply primer, or metal conditioner to bare surfaces in accordance with manufacturer's recommendations, paying particular attention to abrasions, welds, bolts, and nuts. Allow to set as recommended by manufacturer.
 - C. **Steel - Prime Coated:**
 1. Remove loose primer and rust; sand to feather-edge at adjacent sound primer by cleaning in accordance with SSPC SP2 "Hand Tool Cleaning" and SP3 "Power Tool Cleaning".
 2. Apply primer or metal conditioner to abrasions, welds, bolts, and nuts in accordance with manufacturer's recommendations. Allow to set as instructed by manufacturer. Rinse with clean water with rust inhibitor mixed-in or applied primer or metal conditioner immediately following rinse. Allow to dry.
 3. Prime coat bare areas immediately.
 4. Apply specified primer to bare steel and previously primed steel surfaces scheduled to receive special coatings.
 - D. **Steel - Galvanized:**
 1. Remove white rust by cleaning in accordance with SSPC SP2 "Hand Tool Cleaning" and SP3 "Power Tool Cleaning".
 2. Exercise care not to remove galvanizing.
- 3.5 PROTECTION
- A. Protect elements surrounding the work of this Section from damage or disfiguration.
 - B. Repair damage to other surfaces caused by work of this Section.
 - C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
 - D. Remove empty paint containers from site.
- 3.6 APPLICATION
- A. Apply products in accordance with manufacturer's instructions.
 - B. Final Finish Coats: Visual evidence of solid hiding and uniform appearance, free and smooth of brush marks, streaks, sags, runs, laps, or skipped areas.
 - C. Apply each coat to uniform finish and thickness.
 - D. Allow applied coat to dry before next coat is applied.
- 3.7 CLEANING/TOUCH-UP
- A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
 - B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.
 - C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
 - D. Spot painting will be allowed to correct soiled or damaged paint surfaces only when touch-up spot will blend into surrounding finish and is invisible to normal viewing. Otherwise, re-coat entire section to corners or visible stopping point.
- 3.8 FIELD QUALITY CONTROL
- A. **Request acceptance of each coat from Architect before applying succeeding coats.**
 - B. Initiate and maintain for duration of Project field quality control program using certified calibration and testing devices and to ensure conformance with application requirements.
- 3.9 SPECIAL COATING SCHEDULE
- A. **Coating System No. 1 - Exterior Metals.**
 1. **Surface:** Handrails, guardrails, pipe bollards, exposed steel lintels.
 2. **Color and Sheen:** As selected by Architect.
 3. **Application Method:** Spray.
 4. **Prime Coat:** Type P1, DFT 2.0 to 4.0 mils.
 5. **Intermediate (Second) Coat:** Type U1, DFT 3.0 to 4.0 mils.

6. **Top (Third) Coat:** Type U1, DFT 3.0 to 4.0 mils.
- B. **Coating System No. 2 - Interior Metals.**
1. **Surface:** Ferrous metal handrails and guardrails.
 2. **Color and Sheen:** To match Architect's color sample or as schedule by Architect from full and complete line of RAL colors.
 3. **Application Method:** Spray.
 4. **Prime Coat:** Type P1, DFT 2.0 to 4.0 mils.
 5. **Intermediate (Second) Coat:** Type E1, DFT 3.0 to 5.0 mils.
 6. **Top (Third) Coat:** Type U2, DFT 2.0 to 3.0 mils.

END OF SECTION

SECTION 101103

VISUAL DISPLAY BOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

A. Section includes:

1. Tackboards.
2. Porcelain markerboards.
3. Glass markerboards.
4. Visual display wall coverings.
5. Glass display case.
6. Cabinet Whiteboards.
7. Glass dry erase markerboards.

1.3 SUBMITTALS

- A. **Product Data:** For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
- B. **Samples for Verification:** For each type of visual display unit indicated.
- C. **Sample Warranties:** For special warranties.
- D. **Maintenance Data:** For visual display units to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display boards, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefabricate components at the factory, disassemble for delivery, and make final joints at the site.

1.5 WARRANTY

- A. **Special Warranty for Porcelain-Enamel Face Sheets:** Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces become slick or shiny.
 - c. Surfaces exhibit crazing, cracking, or flaking.
 2. **Warranty Period: 20 years from date of Substantial Completion.**

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 MATERIALS, GENERAL

- A. **Porcelain-Enamel Face Sheet:** Manufacturer's standard steel sheet with porcelain-enamel coating fused to steel; uncoated thickness indicated.
 - 1. **Gloss Finish:** Gloss as indicated; dry-erase markers wipe clean with dry cloth or standard eraser.
- B. **Natural Cork Sheet:** Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish with surface-burning characteristics indicated.
- C. **Vinyl Fabric:** Mildew resistant, washable, complying with FS CCC-W-408D, Type II, burlap weave; weighing not less than 13 oz./sq. yd.; with surface-burning characteristics indicated.
- D. **Hardboard:** AHA A135.4, tempered.
- E. **Particleboard:** ANSI A208.1, Grade 1-M-1.
- F. **Fiberboard:** ANSI A208.2, Grade MD.
- G. **Extruded Aluminum:** ASTM B 221, Alloy 6063.
- H. **Laminating Adhesive:** Manufacturer's standard moisture-resistant thermoplastic type.

2.3 TACKBOARD ASSEMBLIES

- A. **Vinyl-Fabric-Faced Tackboard:** 1/8-inch- (3-mm-) thick, vinyl-fabric-faced cork sheet factory laminated to 3/8-inch- (9.5-mm-) thick fiberboard backing.
 - 1. **Acceptable Manufacturers:**
 - a. Claridge Products & Equipment, Inc.
 - b. Best-Rite Manufacturing.
 - c. Egan Visual, Inc.
 - d. PolyVision Corporation, a Steelcase Company.
 - 2. **Basis of Design:** Claridge; Series 3 Type A with concealed fasteners, top map rail and bottom chalk rail.
 - a. **Tackboard Color:** As selected by Architect from manufacturer's full line of products.
 - b. **Trim Color:** Clear anodized.

2.4 PORCELAIN MARKERBOARD ASSEMBLIES

- A. **Porcelain-Enamel Markerboards:** Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch-thick, porcelain-enamel face sheet with high-gloss finish.
 - 1. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Best-Rite Manufacturing.
 - b. Claridge Products and Equipment, Inc.
 - c. PolyVision Corporation; a Steelcase company.
 - d. Egan Visual Inc.
 - 2. **Manufacturer's Standard Core:** Minimum 1/4 inch 6 mm thick, with manufacturer's standard moisture-barrier backing.
 - 3. **Laminating Adhesive:** Manufacturer's standard, moisture-resistant thermoplastic type.
 - 4. **Basis of Design:** Claridge; Series 3 Type A with concealed fasteners, top map rail and bottom chalk rail.

2.5 GLASS MARKERBOARD ASSEMBLIES

- A. **Basis of Design:**
 - 1. **Acceptable Manufacturer:** Clarus.
 - 2. **Product:** Clarus Float.
 - 3. **Glass:** 1/4 inch thick tempered safety glass.
 - 4. **Color:** As selected by Architect.
 - 5. **Accessories:**
 - a. One box marker holder for each board.
 - b. Four hoop magnets for each boards.

2.6 VISUAL DISPLAY WALL COVERINGS

- A. **Visual Display Wall Covering:** Intended for use with dry-erase markers and as a projection surface and consisting of low-gloss, plastic film bonded to fabric backing; not less than 0.020-mil (0.0005-mm) total thickness.
 - 1. **Basis-of-Design:** Walltalkers; a division of RJF International Corporation; Just Rite, JR48-00 with scrim backing or approved equal. **Note: Submit samples of manufacturer's options of Visual Display Wall Coverings for Architect's review and selection.**
- B. **Adhesive:** Mildew-resistant, nonstaining, **strippable** adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall covering manufacturer.
- C. **Primer/Sealer:** Mildew-resistant primer/sealer complying with requirements in Section 099000 and recommended in writing by wall covering manufacturer for intended substrate.
- D. Install and adhere 20 gauge sheet metal to wall behind Visual Display Wall Covering and ensure flatness prior to installing Visual Display Wall Covering.

2.7 GLASS FRONT LOCKABLE DISPLAY CASE

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products to be incorporated into the Work include, but are not limited to the following:
 - 1. Claridge
- B. **Size:** 36 inches wide by 30 inches tall
- C. **Mounting:** Recessed.
- D. **Finish:** Clear anodized aluminum.
- E. **Basis-of-Design:** Claridge; Contemporary Series.

2.8 CABINET WHITE BOARDS

- A. **Acceptable Manufacturers:**
 - 1. Egan Visual
 - 2. Nucraft
- B. **Basis of Design:**
 - 1. Egan Visual Wood Presentation Cabinet # CABW48 with bullnose edge and hardwood veneer. Veneer, stain and finish to be selected by Architect.
 - a. Tackable interior on both side panels
 - b. Full low glare whiteboard porcelain center section with marker tray below.
 - c. Finishes to be selected by Architect from manufacturer's full and complete line of finishes.

2.9 VISUAL DISPLAY BOARD ACCESSORIES

- A. **Aluminum Frames and Trim:** Fabricated from not less than 0.062-inch-(1.57-mm-) thick, extruded aluminum; of size and shape indicated.
 - 1. **Factory-Applied Trim:** Manufacturer's standard.
- B. **Chalktray:** Manufacturer's standard, continuous, extruded aluminum, solid type with ribbed section and smoothly curved exposed ends.
- C. **Visual Display Rails:** Manufacturer's standard, aluminum-framed, tackable fabric visual display surface fabricated into narrow rail shape and designed for displaying material.
 - 1. Provide continuous display rail along entire length of top of markerboards.

2.10 FABRICATION

- A. Fabricate visual display surfaces to sizes indicated on Drawings.
- B. **Porcelain-Enamel Visual Display Assemblies:** Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive. Color to be selected by Architect.
- C. **Visual Display Boards:** Factory assemble visual display boards, unless otherwise indicated.

1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display boards at manufacturer's factory before shipment.
- D. **Factory-Assembled Visual Display Units:** Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.
 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
 2. Provide manufacturer's standard vertical-joint spline or H-trim system between abutting sections of markerboards.
 3. Provide manufacturer's standard mullion trim at joints between markerboards and tackboards of combination units.
- E. **Aluminum Frames and Trim:** Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.
 1. Where factory-applied trim is indicated, trim shall be assembled and attached to visual display units at manufacturer's factory before shipment.
- F. **Aluminum Anodic Finish:** Class II, anodic coating complying with AAMA 611. Refer to Document 008900 and Finish Selection Summary Spreadsheet for colors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, and substances that will impair bond between visual display boards and surfaces.
- B. Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- C. **Visual Display Boards:** Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches(400 mm) o.c. Secure both top and bottom of boards to walls.
 - a. Attach chalktrays to boards with fasteners at not more than 12 inches(300 mm) o.c.
- D. **Visual Display Wall Coverings:** Comply with visual display wall covering manufacturers' written installation instructions.
 1. After installation, clean visual display wall covering according to manufacturer's written instructions. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.
- E. Attach one cleaning label to visual display surface in each room. Cover and protect visual display surfaces after installation and cleaning.

3.2 SCHEDULE

- A. Deans Office: One Clarus Glassboard, 6' x 4'.
- B. Porcelain Markerboards:
 1. Classroom 101: Two 8' x 4'.
 2. Classroom 103A: Two 8' x 4'.
 3. Classroom 103B: Two 8' x 4'.
 4. Nursing Debriefing: One 8' x 4'.
 5. Classroom 204: One 8' x 4'.
 6. Classroom 302: Two 8' x 4'.
 7. Classroom 304: One 8' x 4'.
 8. Classroom 340: Two 8' x 4'.
 9. Classroom 446: One 8' x 4'.
- C. Conference Room 411: One 4' x 4' cabinet.

END OF SECTION

SECTION 101400

SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes (Note: Not all of the products listed may be use on this Project):**

1. Interior room signs.
2. Public Toilet room signs.
3. Bronze Building plaques.
4. Exterior building dimensional letters. (Not Used)
5. Monument sign.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Samples:** At the same time shop drawings are submitted, submit full-sized sample of each type of sign conforming to specification requirements as to letter size, spacing and style.
- C. **Shop Drawings and Manufacturers' Brochures:** Submit in accordance with Section 013300.
- D. Template: Submit full-size template drawing for approval of letter size, stock, spacing, setting screws.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers:** Subject to compliance with requirements indicated, provide products of one of the following:
 1. APCO.
 2. Lassiter Industries.
 3. ASI Sign Systems, Grand Prairie, Texas
 4. Nelson-Harkins, Chicago, Illinois
- B. Substitutions: Under provisions of the General Conditions.

2.2 INTERIOR ROOM SIGNS

- A. General: Provide room identification signs and room numbers as scheduled on Drawings and below.
- B. Mechanically or adhesively attach as recommended by sign manufacturer.
- C. **Interior Signage Plaques:**
 1. **Typical Interior Room Sign:** Plastic nameplate with acetate insert, acrylic accent bar, brushed aluminum plate with raised Braille, and ADA number. Provide one per interior room. Attach to wall adjacent to room per ADA/TAS requirements. Refer to drawings for layout.
 2. **Elevator Fire Exit Sign:** Plastic plaque meeting Life Safety and Building Codes with floor plan and fire egress shown and raised Braille. Provide one per elevator landing. Attach to wall adjacent to elevator door as required by code.
 3. **Public Toilet Rooms:** Identification signs with handicap accessible symbol, "MEN" or "WOMEN" indicated as appropriate and raised Braille. Provide one per toilet room. Attach per ADA/TAS requirements. Refer to drawings for layout.
 4. **Directional Signage as indicated on Drawings.**

5. **Fire Exiting Signage for fire stairs.** Provide one plaque per landing on public side and stair side of door as required by code. Refer to drawings for additional information.
- D. **Graphic Process:**
1. Raised tactile characters 1/32 inch from sign face.
 2. Provide Grade 2 braille for each text immediately below text.
 3. Meet requirements of most current edition of ADA and TAS.
- E. **Font: Optima.**
- F. **Copy:** To be provided by Owner during submittal stage.
- G. Place signs in locations indicated on Drawings and per ADA/TAS requirements.
- H. Properly finish edges of signs and with letters and numbers evenly and accurately cut.
- I. Spacing of Letters and Numbers: Optically correct.
- J. **Basis of Design Product:** APCO "Elevate" with "Scroll" decorative shaped header. Shape and sign design to match Architect's signage drawing sheets in documents.
- K. **Similar Product:** Lassiter Industries; similar to Changeable Message Series CM009, with overall dimensions to be increased to 6-1/4 inches high by 7-1/2 inches wide.
- L. **Where sign is mounted on glass, provide matching blank plate on back side of glass.**
- 2.3 **BUILDING PLAQUE**
- A. **Acceptable Manufacturers:**
1. Advance Corporation; Braille-Tac Division.
 2. A. R. K. Ramos.
 3. Gemini Incorporated.
 4. Matthews International Corporation; Bronze Division.
 5. Metal Arts; Div. of L&H Mfg. Co.
 6. Mills Manufacturing Company.
 7. Nelson-Harkins Industries.
 8. Southwell Company (The).
- B. **Cast Plaques:** Building Plaque. Provide castings free of pits, scale, sand holes, and other defects, as follows:
1. **Plaque Material:** Bronze.
 2. **Border Style:** Satin/brushed bronze.
 3. **Font and Texture:** Seneca, satin/brushed bronze.
 4. **Background Texture:** Manufacturer's standard leatherette texture in oxidized dark bronze.
 5. **Mounting:** Concealed studs for substrates encountered.
 6. **Size:** 24" wide x 30" high, unless otherwise indicated on plans or Owner's standard.
 7. **Design:** Refer to Drawings.
 8. **Copy:** To be provided by Owner during submittal stage.
 9. **Location:** Locate one each plaque in West Building Lobby and Southeast Vestibule. Coordinate final location with Architect during submittal stage or prior to completion of rough framing (for blocking location).
- 2.4 **DIMENSIONAL CHARACTERS**
- A. **Acceptable Manufacturers:**
1. Advance Corporation; Braille-Tac Division.
 2. A. R. K. Ramos.
 3. Gemini Incorporated.
 4. Metal Arts; Div. of L&H Mfg. Co.
 5. Mills Manufacturing Company.
 6. Nelson-Harkins Industries.
 7. Southwell Company (The).
- B. **Cast Characters:** Produce characters with smooth flat faces, sharp corners, and precisely formed lines and profiles, free of pits, scale, sand holes, and other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Alloy and temper recommended by

sign manufacturer for casting process used and for use and finish indicated. Comply with the following requirements.

1. **Character Material:** Aluminum.
2. **Dimensions:** 10 inch tall.
3. **Thickness:** 2 inches thick.
4. **Font:** As selected by Architect.
5. **Finish:** Clear or Bronze anodized, or painted white. Confirm final finish and color with Architect.
6. **Type and Copy:**
 - a. Final copy to be determined with Owner during submittal process. For bid purposes include "Health Science & Human Services Center" on the building exterior.
7. **Mounting:** As indicated on drawings, or if none indicated, projected on 2 inch standoffs.
8. **Final location:** To be determined by Architect.
9. Contractor shall provide all required circuiting and conduit from electrical panels provide fully operational backlighted signage.

2.5 **RESERVED HANDICAPPED PARKING SIGNS**

- A. Screen-printed, 18 gage bonderized steel with blue baked enamel finish and white screen printed copy.
- B. **Size:** Refer to Drawings.
- C. **Copy:**
 1. "Reserved Parking".
 2. "Van Accessible".
- D. **Post:** Refer to Drawings. Provide 2-inch square aluminum tube frame with **powder coat "MSU burgundy" painted finish**. Top portion of frame shall have metal mesh background for sign attachment. Mesh paint color to be **"MSU burgundy."** Obtain RAL or Pantone color specification from MSU facilities.
- E. Provide one per handicap parking space.

2.6 **MONUMENT SIGN**

- A. Relocate existing masonry monument sign from MaGaha Building to Health Science site. Provide two new ground mounted floor light (one per side). Revise dimensional characters to name of new building.

PART 3 - EXECUTION

3.1 **DELIVERY AND STORAGE**

- A. Deliver and store identifying devices in protective wrappings until ready for installation.

3.2 **INTERIOR INSTALLATION - ROOM SIGNS**

- A. **Install signs plumb, level and square and in proper planes with other work, at heights as required by ADA/TAS.**
- B. Anchor each plastic sign with sufficient amount adhesive for proper installation as recommended by manufacturer for substrate.

3.3 **EXTERIOR INSTALLATION - PARKING SIGNS**

- A. Refer to Drawings. Set posts in concrete piers vertical and plumb. Coat aluminum posts with bituminous coating prior to setting in concrete.

3.4 **EXTERIOR INSTALLATION - BUILDING SIGNS (NOT USED)**

- A. General: Install plaques and exterior building signage using mounting methods indicated and according to manufacturer's written instructions.
 1. **Provide wood blocking or plywood backing where building address dimensional letters are to be located.**

2. **Verify location of building address dimensional lettering in field with Architect, Owner and Fire Marshal prior to installing building sheathing.**
 3. Install letters, signs and plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
 4. Install letters, signs and plaques so they do not protrude beyond or obstruct space per accessibility standards.
 5. Before installation, verify that surfaces are clean and free of materials or debris that would impair installation.
 6. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- 3.5 CLEANING
- A. Remove protective materials and clean all signs. Clean surfaces with plain water or water with soap or household detergent.
- 3.6 SCHEDULE
- A. Refer to signage schedule on the Drawings and as follows:
 1. One room name and number sign for each room in the building.
 2. Two wayfinding signs, with department names and suite numbers on each floor.
 3. Elevator/Exit signage at each elevator lobby.
 4. One building plaque at the West Atrium and one at Southeast Vestibule to Atrium.
 5. Relocate one exterior monument sign at west side of building. Confirm final location with Design Architect. Obtain existing sign from Owner. Construct campus standard base and support as required. Provide ground mounted flood lights and power/circuiting as required for fully operational lighting on North and South sides of signage.

END OF SECTION

SECTION 102113

STAINLESS STEEL TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Related Documents: Provisions established in General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.
- B. **Section Includes:**
 - 1. **Floor mounted, overhead braced stainless steel toilet compartments with no sight lines.**
 - 2. **Wall mounted stainless steel urinal screens.**
 - 3. **Mounting and operating hardware.**

1.2 SUBMITTALS

- A. General: Submit in accordance with Section 007013 and Section 013100.
- B. **Product Data:** Submit manufacturer's product data and catalog cut sheets.
- C. **Shop Drawings**
- D. Indicate partition layouts, swing of doors, elevations, anchorage and mounting details, components, hardware, finishes, and relevant dimensions.
 - 1. Furnish location template drawings for anchorage locations in supporting members for attachment of partitions.
- E. **Samples:** Submit full range of color samples of **actual finish** (2 by 3 inch minimum size), **not color photo representations.**
- F. Manufacturer's Instructions: Submit manufacturer's printed installation instructions.

1.3 QUALITY ASSURANCE

- A. **Regulatory Requirements:** Conform to Americans with Disabilities Act Accessibility Guidelines (**ADAAG**), ANSI A 117.1, or local or state code for provisions for the physically handicapped, whichever is more stringent.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle materials in accordance with the requirements of Sections 01 60 00.
- B. Store materials in weather tight location.
- C. Keep materials in original wrappers until installation is complete.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate Work with placement of anchorage devices. Supply rough-in data in sufficient time for concealed preparatory work to be conducted.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers:** Subject to compliance with requirements herein, provide products from one of the following:
 - 1. Hadrian Inc., Menotr, OH.
 - 2. Accurate Partitions Corporation, Lyons, IL.
 - 3. All American Metal Corporation, Freeport, NY.
 - 4. American Sanitary Partition Corporation, Ocoee, FL.
 - 5. Ampco Products, Inc., Miami, FL.
 - 6. General Partitions Manufacturing Corporation, Erie, PA.

7. Global Partitions, Eastonollee, GA.
 8. Knickerbocker Partition Corporation, Freeport, NY.
 9. Metpar Steel Products Corp., Westbury, NY.
 10. Sanymetal Products Company, Somerset, KY.
 11. Weis/Robart Partitions, Inc., Wayne, MI.
- B. Substitutions: In accordance with the requirements of Section 01 60 00

2.2 ACCEPTABLE PRODUCTS

1. **Basis of Design:**
 - a. Hadrian, Inc., No Sight Line, Standard Series, floor mounted overhead braced partitions.
 - b. Or approved equal.
2. **Finish:** #4 brushed stainless steel.

2.3 MATERIALS

- A. **Stainless Steel**
 1. ASTM A 167, Type 302/304, satin lustre finish.
 2. **Panels and Doors:** 22 gage minimum (20 gage when recommended by manufacturer) face sheets.
 3. **Pilasters:** 20 gage minimum (18 gage when recommended by manufacturer) face sheets.
- B. **Chrome Plating:** ASTM B 456.
- C. **Pilaster Shoes:** 3 inch high; ASTM A 167, Type 302/304, No. 4 polished finish stainless steel.
- D. **Core:** Manufacturer's standard sound deadening material.
- E. **Mounting Brackets:** Manufacturer's standard heavy duty satin lustre stainless steel or anodized polished aluminum.
- F. **Hardware:**
 1. **Hinge:** Stainless steel or chrome plated brass, continuous hinges, adjustable to hold open at angle up to 90 degrees.
 2. **Latch:** Manufacturer's standard stainless steel or chrome plated brass thumb turn or slide bolt with emergency operation.
 - a. Provide slide bolt in accessible stall.
 3. **Door Strike and Keeper:** Manufacturer's standard stainless steel or chrome plated combination type with rubber face.
 4. **Coat Hook:** Manufacturer's standard stainless steel or chrome plated brass combination hook and rubber tipped pin.
 5. **Door Pull:** Manufacturer's standard stainless steel or chrome plated brass, for out swinging doors.
- G. **Anchorage and Fasteners**
 1. Exposed Fasteners: Manufacturer's standard stainless steel or chrome plated brass with theft-resistant type screw head and nuts.
 2. Concealed Fasteners: Hot-dip galvanized or cadmium plated.

2.4 FABRICATION

- A. Provide compartments of floor anchored and overhead braced style.
- B. Provide urinal screens with combination floor anchored style and wall-supported style.
- C. Take field measurements to ensure proper fitting of Work. Shop assemble to greatest extent possible.
- D. **Partitions, Pilasters, Screens, and Doors**
 1. Assemble to greatest extent possible. Make cutouts for toilet accessories at factory.
 2. Provide formed and closed edges for doors, panels, and pilasters. Miter and weld corners and grind smooth. Provide closed edges in color matching panels.

3. Provide internal reinforcement in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
 - E. **Dimensions**
 1. **Doors:** 1 inch thick minimum units; 24 inch wide inward swing doors and 32 inch wide outward swing doors for handicapped stalls.
 2. **Pilasters:** Manufacturer's standard, 1-1/4 inch minimum thickness.
 3. **Panels:** Manufacturer's standard 1 inch minimum unit.
 4. **Urinal Screens:** 1 inch thick minimum, **18 inches wide by 48 inches tall.**
 - F. **Supports and Hangers:** Equip pilasters with leveling devices, anchor studs, and locking nuts.
 - G. **Pilaster Shoes:** Plinths, one piece, hemmed top and bottom, formed to fit pilaster, equipped with concealed clips, 3 inch height, 20 gage stainless steel.
 - H. **Wall Brackets:** Panel brackets, two ear, "T" style.
 - I. **Pilaster to Pilaster Brackets:** Stirrup style brackets.
- 2.5 FACTORY FINISHING
- A. Clean, degrease, and neutralize panels.
 - B. **Stainless Steel: No. 4 brushed finish.**

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 01 43 00.
- B. Check areas scheduled to receive partitions for correct dimensions, plumbness of walls, soundness of wall surfaces, location of built-in framing/anchorages/bracing, and other conditions that would affect proper installation of holding brackets and anchorage or suspension devices.
- C. **Provide 2 X 4 wood or 3-inch X 3-inch X 1/4-inch steel angle/channel blocking in walls to support partitions at locations of attachments whether or not shown on Drawings.**
- D. Verify spacing of plumbing fixtures to assure compatibility with installation of partitions.
- E. Beginning of installation means acceptance of existing surfaces.

3.2 INSTALLATION

- A. General:
 1. Install partitions and screens rigid, straight, plumb, and level.
 2. **Maintain zero sight lines between pilasters and panels.**
 3. **Maintain zero sight lines between panels and walls.**
 4. Secure panels to walls with not less than 2 stirrups brackets, attached near top and bottom of panel.
 5. Locate wall brackets so that holes for wall anchorages occur in tile joints.
 6. Conceal evidence of drilling, cutting, and fitting to room finish.
- B. **Floor Mounted Overhead Braced Partitions:**
 1. Attach pilasters to supporting floor with pilaster supports anchored with minimum 2 inch penetration into floor system.
 2. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster. Conceal floor fastenings with pilaster shoes.
 3. Level, plumb, and tighten installation with leveling device.
 4. Secure pilaster shoes in position.
 5. Secure headrail to pilaster face with not less than two fasteners preface. Secure headrail to walls.
 6. Set tops of doors parallel with overhead brace when doors are in closed position.
- C. **Combination Floor-Mounted and Wall-Supported Panels and Screens:**
 1. Floor mounted.
 2. Attach to wall with anchoring devices and wall brackets.
 3. Position, level, and tighten units.

3.3 ADJUSTING

- A. Adjust and lubricate hardware for proper operation after installation.
- B. Set hinges on inward swing doors to hold doors open approximately 30 degrees from closed position when unlatched.
- C. Set hinges on outward swing doors to return to fully closed position.
- D. Perform final adjustments to leveling devices and hardware.
- E. Adjust and align hardware for uniform clearance at vertical edges of doors **with no sight lines**.

3.4 CLEANING

- A. Clean surfaces free of oil, dirt, and imperfections.

END OF SECTION

SECTION 102123

CUBICLE CURTAINS AND TRACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

- A. **Product Data:** Submit manufacturer's specifications to evidence compliance with these specifications.
- B. **Shop Drawings:**
 - 1. Show details of the system, related construction and reflected layout of ceiling areas showing location of tracks in relation to other ceiling mounted items.
 - 2. Indicate materials, finishes, dimensions, thicknesses and/or gages of parts, reinforcement, where applicable, and anchorage including items of hardware and accessories necessary for complete installation.
- C. **Samples for Verification:**
 - 1. Curtain: Full size sample.
 - 2. Track: 12 inch long track with end caps and curtain carriers.
- D. **Cubicle Schedule:** Use same room designations as indicated on Drawings.
- E. **Maintenance Data:** For inclusion in maintenance manual required by Division 01.
 - 1. Include manufacturer's instructions for maintenance of installed Work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
 - 2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.3 MAINTENANCE

- A. **Extra Materials:** Furnish as described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Curtain Carriers: Full-size units equal to 3 percent of amount installed for each size indicated.
 - 2. Curtains: Two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Refer to **Section 008900 - Finish Selections Summary**.
- B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers named alphabetically below. If not named, submit as substitution according to Conditions of the Contract and appropriate Division 01 Sections.
 - 1. AR Nelson Co.
 - 2. Construction Specialties, Inc.
 - 3. Imperial Fastener Co.
 - 4. In Pro Corp.
 - 5. Salisbury Industries.

2.2 CUBICLE CURTAINS

- A. **Curtain Fabric:** Product that is equivalent to color, texture, pattern, finish, appearance, and material quality characteristics indicated by basis of design selection.
- B. **Curtain Construction:**

1. Flame Resistance: Comply with NFPA 701.
2. **Curtain Top:** Not less than 20 inch wide nylon mesh with 1/2 inch holes; overlap seams and double-lock stitch to body of curtain.
3. **Width:** Equal to track length plus 10 percent.
4. **Length:** Equal to floor-to-ceiling height minus 20 inches from finished ceiling at top and 12 to 15 inches above finished floor.
5. **Top Hem:** Not less than 1 inch and not more than 1-1/2 inch wide, triple thickness, reinforced with integral web and double stitched; 2 piece, rolled edge, corrosion resistant, nickel-plated brass grommets spaced not more than 6 inches on centers.
6. **Bottom and Side Hems:** Not less than 1 inch wide, reinforced, triple thickness and single stitched.
7. **Seams:** Not less than 1/2 inch wide, double turned and double stitched.

2.3 CURTAIN TRACKS

- A. **Extruded-Aluminum Track:** Not less than 1-1/4 inches wide by 3/4 inch high, with minimum wall thickness of 0.058 inch.
 1. Curved Track: Factory fabricated 12 inch radius bends.
 2. Finish: Clear anodized.
- B. **Track Accessories:** Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
- C. **Curtain Carriers:** Two nylon rollers and nylon axle with chrome-plated steel, stainless steel, or aluminum hook with nickel plated steel beaded chain curtain drop.
- D. **Exposed Fasteners:** Stainless steel.
- E. **Concealed Fasteners:** Hot-dip galvanized.

2.4 IV SUPPORT SYSTEMS

- A. **Extruded-Aluminum IV Track:** Not less than 1-1/4 inches wide by 3/4 inch high; with minimum wall thickness of 0.058 inch.
 1. Curved Track: Factory fabricated 12 inch radius bends.
 2. Finish: Clear anodized.
- B. **IV Carriers:** Four nylon rollers and steel or stainless-steel axles, with hanger loop fabricated from 1/4-inch- diameter stainless steel.
- C. **Telescoping IV Hangers:** 3/4 inch stainless-steel main shaft and a 3/8 inch stainless-steel inner shaft, vertically adjustable 16 inches; with 4 non folding 1/4 inch stainless-steel arms with loops and a stainless-steel top loop to attach to carrier.

PART 3 - EXECUTION

- A. Acceptance of Surfaces and Conditions:
 1. Examine substrates to which cubicle specialties will be applied for compliance with requirements and other conditions affecting performance.
 2. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
 3. Starting Work within a particular area will be construed as acceptance of surface conditions.

3.2 INSTALLATION

- A. Installation Quality Standards: In addition to standards listed elsewhere, perform work according to following, unless otherwise specified:
 1. Respective manufacturer's installation instructions.
 2. Approved submittals.
 3. Contract Documents.

- B. General: Install tracks level and plumb, according to manufacturer's written instructions. Provide track fabricated from one continuous length up to 16 feet.
 - 1. Curtain Track Mounting: Surface.
 - 2. IV Track Mounting: Surface.
- C. Surface Track Mounting: Fasten surface-mounted tracks at intervals of not less than 24 inches. Fasten support at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Mechanically fasten to suspended ceiling grid with screws.
- D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- E. IV Hangers: Unless otherwise indicated, install one IV hook on each IV track and hang one IV hanger.
- F. Curtain Carriers: Provide curtain carriers adequate for 6 inch spacing along the full length of the curtain plus an additional carrier.

END OF SECTION

SECTION 102226
OPERABLE PARTITIONS

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 **SUMMARY**
 - A. **Section Includes:**
 - 1. **Manually-operated, acoustical panel partition and enclosure.**
- 1.3 DEFINITIONS
 - A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."
 - B. STC: Sound Transmission Class.
- 1.4 **PERFORMANCE REQUIREMENTS**
 - A. **Delegated Design:** Design operable panel partitions, including comprehensive engineering analysis by a qualified professional engineer, registered in the state the Project is located, using performance requirements and design criteria indicated.
 - B. **Acoustical Performance:** Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:
 - 1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
- 1.5 **SUBMITTALS**
 - A. **Product Data:** For each type of product indicated.
 - B. **Sustainable Submittals:**
 - 1. Product data for each composite wood product used in operable panel partitions, documentation indicating that product contains no urea formaldehyde.
 - C. **Shop Drawings:** Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data for attachments, signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
 - D. **Samples for Initial Selection:** For each type of exposed material, finish, covering, or facing indicated.
 - 1. Include similar Samples of accessories involving color selection.
 - E. **Delegated-Design Submittal:** For operable panel partitions indicated to comply with performance requirements, including analysis data and calculations signed and **sealed by the qualified professional engineer**, registered in the state the Project is located, responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for seismic restraints.
 - F. **Setting Drawings:** For embedded items and cutouts required in other work, including support-beam, mounting-hole template.
 - G. **Qualification Data:** For qualified Installer.
 - H. **Product Certificates:** For each type of operable panel partition, from manufacturer.
 - I. **Operation and Maintenance Data:** For operable panel partitions to include in maintenance

manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Panel finish facings and finishes for exposed trim and accessories. Include precautions for cleaning materials and methods that could be detrimental to finishes and performance.
2. Seals, hardware, track, carriers, and other operating components.

J. **Warranty:** Sample of special warranty.

1.6 **QUALITY ASSURANCE**

- A. **Installer Qualifications:** An employer of workers trained and approved by manufacturer with at least **ten years' experience** of documented successful installations.
- B. **Fire-Test-Response Characteristics:** Provide panels with finishes meeting one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 1. **Surface-Burning Characteristics:** As determined by testing per ASTM E 84.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 2. **Fire Growth Contribution:** Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

1.7 **PROJECT CONDITIONS**

- A. **Field Measurements:** Verify actual dimensions of operable panel partition openings by field measurements before fabrication.

1.8 **WARRANTY**

- A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of operable panel partitions.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal wear.
 2. **Warranty Period: Two years** from date of Substantial Completion.

1.9 **EXTRA MATERIALS**

- A. Furnish extra materials from the same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. **Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of two panels when installed.**

PART 2 - PRODUCTS

2.1 **MATERIALS**

- A. **Steel Frame:** Steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.
- B. **Steel Face/Liner Sheets:** Tension-leveled steel sheet, manufacturer's standard nominal minimum thickness for uncoated steel.
- C. **Gypsum Board:** ASTM C 36.
- D. **Medium-Density Fiberboard:** ANSI A208.2, made with binder **containing no urea formaldehyde.**

2.2 OPERABLE ACOUSTICAL PANELS

- A. **Operable Acoustical Panels:** Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
 - 1. **Acceptable Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Advanced Equipment Corporation.
 - b. Hufcor.
 - c. Curtition; KWI-K-WALL Company.
 - d. Modernfold, Inc.; a DORMA Group Company.
 - e. Panelfold Inc.
 - 2. **Basis-of-Design:** Refer to Section 008900 - Finish Selection Summary.
- B. **Panel Operation: Manually operated, single panels.**
- C. **Panel Construction:** Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.
- D. **Dimensions:** Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.
 - 1. **Panel Width:** Standard widths, refer to Drawings.
- E. **STC: Not less than 52.**
- F. **Panel Weight:** 8 lb/sq. ft. maximum.
- G. **Panel Thickness:** Not more than 4 inches nominal.
- H. **Panel Closure:** Manufacturer's standard.
 - 1. **Initial Closure:** Flexible, resilient PVC, bulb-shaped acoustical seal.
 - 2. **Final Closure:** Constant-force, lever-operated mechanical closure expanding from panel edge to create a constant-pressure acoustical seal.
- I. **Hardware:** Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.
 - 1. **Hinges:** SOSS invisible laminated hinge with antifriction segments.
- J. **Locations:** Refer to schedule at end of this Section.

2.3 SEALS

- A. **General:** Provide types of seals indicated that produce operable panel partitions complying with acoustical performance requirements and the following:
 - 1. Manufacturer's standard seals.
 - 2. Seals made from materials and in profiles that minimize sound leakage.
 - 3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.
- B. **Horizontal Top Seals:** One of the following:
 - 1. Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track.
 - 2. PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.
 - 3. Continuous-contact, extruded-PVC seal exerting uniform constant pressure on track or PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on track when extended.
- C. **Horizontal Bottom Seals:** PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
 - 1. **Automatically Operated for Acoustical Panels:** Extension and retraction of bottom seal automatically operated by movement of partition, with operating range **not less than 2 inches** between retracted seal and floor finish.

2.4 FINISH FACING

- A. **General:** Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant non-staining adhesive as recommended by facing manufacturer's written instructions.
 - 1. Apply one-piece, seamless facings free of air bubbles, wrinkles, blisters, and other defects, with edges tightly butted, and with no gaps or overlaps. Horizontal seams are not permitted. Tightly secure and conceal raw and selvage edges of facing for finished appearance.
 - 2. Where facings with directional or repeating patterns or directional weave are indicated, mark facing top and attach facing in same direction.
 - 3. **Color/Pattern:** \$45/SY Material only; C.O.M. fabric and stain grade wood veneer; refer to Document 008900 - Finish Selections Summary.
- B. **Cap-Trimmed Edges:** Protective perimeter-edge trim with tight hairline joints concealing edges of panel and finish facing, finished as follows:
 - 1. **Aluminum:** Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper required to comply with performance requirements; and with manufacturer's standard clear anodic finish.

2.5 SUSPENSION SYSTEMS

- A. **Suspension Tracks:** Steel or aluminum with adjustable steel hanger rods for overhead support, designed for type of operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.
 - 1. **Panel Guide:** Aluminum; finished with factory-applied, decorative, protective finish.
 - 2. **Head Closure Trim:** As required for acoustical performance; with factory-applied, decorative, protective finish.
- B. **Carriers:** Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.
- C. **Aluminum Finish:** Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.
- D. **Steel Finish:** Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.
- E. **Structural Steel Bracing and Support:** Provide miscellaneous steel structure as indicated on the Drawings, or, if none shown, as required to support track and panels from building structure. Refer to Section 055000, Metal Fabrications.

2.6 ACCESSORIES

- A. **Storage Pocket Door:** Full height at end of partition run to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware and acoustical seals at soffit, floor, and jambs. Use concealed Soss hinges.
 - 1. Manufacturer's standard method to secure storage pocket door in closed position.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable panel partitions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.
- B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed.
- C. **Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.**
- D. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.3 ADJUSTING

- A. **Adjust operable panel partitions to operate smoothly, without warping or binding.** Lubricate hardware and other moving parts.
- B. Adjust pass doors storage pocket doors to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.4 FIELD QUALITY CONTROL

- A. **Light-Leakage Test:** Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids; adjust partitions for acceptable fit.
- B. **Testing Methodology: Perform testing of installed operable panel partition for noise isolation** according to ASTM E 336, determined by ASTM E 413, and rated for not less than NIC indicated. Adjust and fit partitions to comply with NIC test method requirements.
- C. Testing Extent: Testing agency shall randomly select one operable panel partition installation(s) for testing.
- D. Repair or replace operable panel partitions that do not comply with requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of repaired, replaced, or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.5 CLEANING

- A. Clean soiled surfaces of operable panel partitions to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials according to manufacturer's written instructions.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

3.7 SCHEDULE

- A. **Demising wall between Dental Hygiene Lab / Classrooms 103A and 103B.**

END OF SECTION

SECTION 102233

HORIZONTAL SLIDING ACCORDION-TYPE FIRE DOORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes: Horizontal sliding, accordion-type fire doors.**

1.2 SUBMITTALS

- A. **Shop Drawings:** Indicate required stacking depth, storage pocket width and height of header above finished floor. Show installation details, layout, and electrical requirements.

1.3 QUALITY ASSURANCE

- A. **Installation shall be performed by factory trained and certified installers with a minimum of three years experience installing accordion-type fire doors.**
- B. Fire doors shall be listed by Underwriters Laboratories for ratings as indicated, when tested in accordance with the requirements of UL 10B and NFPA252.
- C. Automatic closing system shall be listed by Underwriters Laboratories in accordance with the requirements of UL 864 and be intended for use with assembly in compliance with NFPA 80, Chapter 9, Section 9.4.2.1.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to the job site in manufacturer's original, unopened package.

1.5 COORDINATION

- A. Coordinate the efforts of the various trades affected by the work of this section. Assure accurate installation of header, jamb, and trim. Provide field dimensions for fabrication. Supervise unloading and handling of materials.
- B. After testing the fire alarm system, automatic-closing fire doors shall be re-set to the original positions.
- C. Store boxes flat (not more than three high) in a dry area and protect from elements that may damage materials. Replace damaged materials at no cost to the owner.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. **Basis of Design: Horizontal sliding accordion-type fire doors shall be Won-Door FireGuard 60 as manufactured by Won-Door Corporation.**
- B. Products of other manufacturers demonstrating complete compliance with each of the fire rating and performance criteria of the product specified will be considered for approval. Minimum proof of compliance shall include UL test report and independent testing agency report documenting compliance with IBC Section 1008.1.3.3 and NFPA 80, Chapter 9.

2.2 FIRE RATING

- A. Fire Doors shall be listed by Underwriters Laboratory as special purpose fire doors having a 60 minute fire-resistive rating in accordance with the requirements of UL 10B and NFPA 252.

2.3 REMOTE MONITORING AND CONTROL

- A. Fire doors shall be capable of being remotely monitored and controlled by a personal computer (PC). Information displayed on the computer shall indicate the voltage of the battery, AC line voltage and error conditions. Status information shall indicate whether the door(s) is closed, open, closing, opening, stopped, blocked or locked. Access using the Fire Exit Hardware shall be indicated as well as when the door(s) has received a fire signal.

2.4 MATERIALS

- A. **Construction** shall consist of two parallel, accordion-type walls of panels independently suspended with no floor tracks, pantographs, or interconnections except at the lead-post.
- B. **Panels** shall be formed of 24-gauge enamel coated steel V-grooved for strength and resilience. Panels shall be connected by full height 24-gauge enamel coated steel hinges. Panels shall be modular in design and capable of in-place repair-ability.
- C. **Suspension System** shall consist of two 14-gauge cold rolled steel (or .125 aluminum) tracks on 8" centers attached to the overhead structural support. Each lead post shall be suspended by an 8-wheel ball bearing trolley. Each panel shall be suspended by a steel hanger pin and a ball bearing roller.
- D. **Lead-posts** shall be of 24-gauge cold rolled steel and shall be connected by specially formed steel panels. An internally mounted stabilizer bar shall keep lead-posts plumb and in proper alignment during operation and insure a tight fitting closure. On model FG CC the leadpost shall also function as an integrated storage pocket cover door.
- E. **Perimeter Seals** shall consist of continuous extruded vinyl sweeps attached to the top and bottom of the fire door to form a smoke and draft seal.
- F. **Hanging weight** shall be 5.5 pounds per square foot.
- G. **Automatic Closing System** shall consist of the following:
 - 1. Microprocessor based Electronic Control box with these features:
 - a. Ability to monitor dual power sources continually for peak performance including:
 - 1) Detect a missing battery, bad battery, or low battery condition.
 - 2) Detect if the charging circuit is bad.
 - 3) Detect fuse failures.
 - 4) Detect high or low AC conditions.
 - b. Ability to monitor the health of the drive train including:
 - 1) Direction errors, obstruction errors, hindrance errors, and position errors.
 - 2) Active daily path checks, by actually closing and opening to assure a clear path and proper operation.
 - 3) Ability to monitor a passive input such as an infrared light beam to assure the closing path is clear.
 - c. Ability to monitor inputs including:
 - 1) Sticky door block, exit hardware, patron hardware, and key switches.
 - 2) Key switch miswires where key open and key close are both on simultaneously.
 - d. Ability to self-monitor the health of:
 - 1) Internal volatile and non-volatile memory.
 - 2) Proper operation of firmware.
 - e. Ability to run a "watch dog" monitoring circuit which will force a software restart in the event the software hangs, including the ability to track the number of resets that occur for diagnostic purposes.
 - f. Ability to record the number of times the door has closed, opened, lost communication with external microprocessors, and the number of times the controller has been reset manually.
 - g. Ability to monitor ambient temperature and lockout the operating devices once the environment at the door becomes untenable.
 - h. Ability to enter a security mode to help control access through the door including:
 - 1) The ability to automatically re-close and secure itself after a legitimate patron access has occurred.

- 2) The ability to unlock and revert to a fire door in a fire alarm condition, including the ability to re-lock automatically after the fire alarm condition has cleared.
- i. Ability to withstand voltages up to 120 volts AC on the fire alarm input circuit without damage including the ability to indicate that the alarm circuit has not been wired as a dry contact, "no voltage" circuit when errant voltages are applied to the circuit.
- j. Ability to communicate with other microprocessors on the system via an internal bus system, including but not limited to microprocessors on the motor drive, in the leading edge of the door, and on a wall mounted display panel adjacent to the door.
- k. Ability to indicate trouble or supervised information both locally and at a remote location.
2. Motor Operator Assembly including:
 - a. A DC gear-motor, drive sprocket, clutch, and position sensors. The motor shall drive the fire door by means of a chain attached to a stabilizer bar trolley each time the door operates including the initial closing cycle.
3. A door control momentary rocker switch shall be mounted on one side of the door near the lead post and shall have the following functions: Pressing the upper portion of the switch shall close the door and/or clear fault conditions. Pressing the lower portion of the switch shall open the door and/or temporarily mute the local horn. For doors using wall mounted key switches, **Error! Reference source not found.Option Error! Reference source not found.**, a color coordinated cover plate shall be provided to fill the hole left when the rocker switch is removed.
4. The control box shall be equipped with a service switch that performs the following functions:
 - a. When the switch is off with AC power present, the controller shall emit an audible coded sound indicating the system is out of service. In this mode all normal functions shall cease including motor and communications.
 - b. When the switch is off and AC power is not present, the controller shall enter a sleep mode during which the system shall use the battery to monitor the AC line for power but do nothing else.
 - c. When the switch is moved from the off position to the on position, the controller shall enter a calibrate mode where it emits a coded audible alert indicating that the door needs to be closed to complete the calibration sequence. As soon as the door is closed, the controller shall automatically stop the audible alert, and resume all normal functions and monitoring.
5. Leading Edge Obstruction Detector:
 - a. Shall be pressure sensitive such that each contact with an obstruction shall cause the door to stop, reverse enough to remove pressure on the leading edge, pause, and then re-close when in an alarm condition. The leading edge obstruction detector shall be fully functional at all times, including during the initial closing cycle.
 - b. Constant pressure to the leading edge in the direction of opening shall, while the door is opening under motor power, continue to open under motor power until the leading edge is released. This is termed motor assisted opening.
 - c. Constant pressure to the leading edge while not under motor power shall prevent motor operation and allow the door to be opened manually.
6. Exit Hardware shall be located on both sides of each fire door.
 - a. In emergency mode, a slight pressure on the hardware will cause the door to open a minimum of 32 inches, pause for 3 seconds, and then automatically close.
 - b. The open distance shall be field programmable, up to the entire opening width, if the local authority requires an opening larger than 32 inches.
 - c. The pause before re-close shall be field programmable, up to 30 seconds, if the local authority requires a longer pause time.
 - d. The exit hardware shall have the ability when not in the emergency (fire) mode or the security (lock) mode to be used to open the door and move it back into the storage pocket.

- e. The exit hardware shall be field programmable to provide access control. When programmed, the exit hardware shall not respond when pressed until activated by signal from smoke detector or fire alarm.
- 7. Suffix "E" doors shall include the following extras; track seals, anti-sway brackets every five feet or less across the opening, modified lead post trolleys and foil tape between the panels and the smoke liner.
- 8. On model FG CC the header assembly shall be provided as integrated part of the door assembly.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Openings shall be to the dimensions specified, plumb and level.
- B. Headers shall be parallel with the finished floor within $\pm 1/8$ " tolerance over the entire length of the opening.
- C. Manufacturer shall make available to the general contractor a DVD showing door opening preparation.

3.2 INSTALLATION

- A. Install fire doors in accordance with manufacturer's instructions for clearance and fastenings.
- B. Adjust for smooth, quiet operation. Verify that all operations are functional and meet the requirements of applicable codes and regulations.
- C. Upon completion of the installation, general contractor shall protect fire doors from damage and shall replace or repair subsequent damage so that doors are acceptable to the architect at no additional cost to the owner.
- D. Installation shall be performed by factory trained and certified installers with a minimum of three years experience installing accordion-type fire doors.

3.3 DEMONSTRATION

- A. Manufacturer's onsite field technician shall demonstrate the operation of the doors to the General Contractor. A DVD outlining the operation, scheduled maintenance, basic troubleshooting and care of the door system shall be provided to the owner by the door manufacturer.

END OF SECTION

SECTION 102613
WALL AND CORNER GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section Includes:**
 - 1. Corner Guards on outside corners of interior walls and other locations as indicated on the drawings.
 - 2. Wall Protection Rails.

1.3 PERFORMANCE REQUIREMENTS

- A. **Performance Requirements**
 - 1. All products to meet ASTM E84 characteristics as follows
 - a) **Flame Spread: 25 Maximum.**
 - b) **Smoke Developed: 450 Maximum.**
 - 2. When used as part of a fire rated assembly, devices must be capable of maintaining the specified or indicated hourly rating when tested in accordance with ASTM E119.
- B. Installed component assembly to support vertical live load of 100 lb/lineal ft with deflection not to exceed 1/50 of span between supports.
- C. **Corner guards to resist lateral impact force of 100 lbs at any point without permanent damage.**

1.4 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Samples:** Submit (2) 12 inches long, samples of each type of corner guard specified. Provide actual samples of vinyl colors from manufacturer's stock variety for Architect's selection, if vinyl corner guards are specified.
- C. **Product Literature:** Specific information for products intended to be provided.
- D. Certificates: Submit certificates indicating product's compliance with referenced standards and tests.
- E. Manufacturer's Instructions: Submit manufacturer's recommended installation instructions and suggested fastener types/patterns for each substrate encountered.

1.5 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** Company specializing in manufacture and fabrication of wall protection devices with **ten years' experience.**
- B. Conform to ANSI A117.1 (or local code if more stringent) requirements for the physically handicapped.

1.6 COORDINATION

- A. Coordinate work under provisions of Section 013100.
- B. Coordinate the work with wall or partition Sections for installation of concealed blocking or anchor devices.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in accordance with Section 016000.

1.8 SEQUENCING AND SCHEDULING

- A. Begin work only after substrate work is complete and attachment devices in hollow walls is verified as being accurately placed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Approved Manufacturers:** Subject to compliance with requirements indicated, provide products of one of the following:
 - 1. Inpor, Muskego, WI.
 - 2. IPC.
 - 3. Koroguard Wall Protection Systems, Fairlawn, OH.
 - 4. Construction Specialties Inc., Muncy, PA
 - 5. Pawling Corp., Pawling, NY

2.2 CORNER GUARDS (Refer to Schedule. Note: All of the following products may not be used on this project.)

- A. **Type WP-1: Surface Metal Stainless Steel Corner Guard:**
 - 1. **Design:** Surface applied with adhesive.
 - 2. **Material:** Type 304 Stainless Steel with 1-1/2 inch wide flanges each leg. No. 4 brushed finish.
 - 3. **Height:** 48 inches, or to bottom of chairrail where chairrail is indicated.
 - 4. **Thickness:** 16 gage.
 - 5. **Finish:** No. 4 Satin.
 - 6. **Method of Attachment:** Adhesive.
 - 7. **Basis of Design:** IPC; Model 181124C-304.
- B. **WP-2: Stainless Steel Surface Mounted End Wall Protection Channels:**
 - 1. **Type:** 304 SS.
 - 2. **Size:** As required with 3" return leg on each side of wall.
 - 3. **Height:** Full height of wall.
 - 4. **Basis of Design:** IPC; 427 end wall protection.

2.3 WALL GUARDS

- A. **WP-3: Acrylic Wall Guard:**
 - 1. **Size:** 5" tall with radiused profile.
 - 2. **Material:** 0.080 inch acrylic.
 - 3. **Basis of Design:** Construction Specialties; SCN50 with matching end caps.
 - 4. **Color:** To be selected by Architect from manufacturer's full and complete color lines including metal tones and standard solid colors

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 014300.
- B. Verify that substrate finishes are complete and attachment devices in hollow walls are accurately located.

3.2 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturer's printed instructions.
- B. Located devices as shown on the Drawings or as determined in the field by the Architect.
- C. Stop corner guards at heights indicated. If no heights are indicated, carry device full height of wall. Terminate 48 inch tall units at underside of chairrail where chairrail is present.
- D. Provide wood blocking at locations with screw attachment.
- E. **Attach as recommended by manufacturer.**

1. Provide wood blocking in wall as required.
- 3.3 ADJUSTING
- A. On flush mounted devices, verify that device is flush with adjacent wall surface. Adjust as required for proper fit and appearance.
- 3.4 CLEANING
- A. Remove protective coverings on devices only at final cleaning stage.
- 3.5 SCHEDULE
- A. **Corner Guards:**
 1. **Type WP-1 (Surface Mounted Stainless Steel):**
 - a. Provide on all outside corners of walls in public and high traffic areas as indicated on Drawings, or if none shown, provide 300 units. Confirm final locations with Design Architect.
 - b. Verify height with Architect. At chairrail locations, terminate at bottom of chairrail unless instructed otherwise by Architect.
 2. **Type WP-2 (Surface Mounted End of Wall Protection):**
 - c. Provide end of wall protection at all locations indicated on Drawings, or, if none shown, provide 150 units. Confirm height and final locations with Architect.
 - B. **Wall Guards:**
 1. **Type WP-3 (Vinyl Wall Guard):**
 - a. Provide continuous bumper rail at all Corridor, Laboratory and Health professions department walls in Building. Verify final locations on Drawings and with Architect.
 - b. Verify mounting height with Architect.

END OF SECTION

SECTION 102813

TOILET ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Toilet accessories**
- B. **Attachment hardware and related trim**

1.3 SUBMITTALS

- A. **Product Data:** Submit manufacturer's catalog cut sheets, data sheets, installation instructions, maintenance data, and operating instructions.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. **Conform to ANSI A117.1, Texas Accessibility Standards, and Americans With Disabilities Act** (or local code if more stringent requirement is applicable) for installing work for accessibility to the disabled.

1.5 SEQUENCING AND SCHEDULING

- A. Coordinate work with placement of wall reinforcement and reinforcement/fabrication of toilet partitions to receive anchor attachments. Supply rough-in data in sufficient time to be built into other work.
- B. Do not install accessories until room finishes are completed.
- C. **Provide all necessary wood blocking and/or steel structure to support toilet accessories as part of this scope of work.**

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Sheet Steel: ASTM A 366, commercial quality.
- B. Zinc Coating: ASTM A 123.
- C. Chrome Plating: ASTM B 456, Type SC2.
- D. Stainless Steel Sheet: ASTM A 167.
- E. Stainless Steel Tubing: ASTM A 269, stainless steel.
- F. Fasteners, Screws, and Bolts: Hot dip galvanized ASTM A386 where concealed; finish to match device where exposed.
- G. Expansion Shields: Type as recommended by accessory manufacturer for component and substrate.

2.2 BASIS OF DESIGN

- A. Multi-roll Toilet Paper Dispenser: Wausau Paper; 772169.
- B. Paper Towel Dispenser: Wausau Paper; Opti-Serv Hybrid, 77510.
- C. Soap Dispenser: Gojo; LTX12, black, and integral mounted Gojo drip tray.

2.3 PUBLIC-USE WASHROOM ACCESSORIES

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Bobrick Washroom Equipment, Inc.
- B. **Toilet Tissue (Roll) Dispenser (TA-1)** at Multi-Fixture Restrooms: (OFCI)
1. **Basis of Design:** Bobrick B-27460, surface mounted.
 2. Description: Double roll dispenser without controlled delivery; lockable spindles.
 3. Accessible: Yes.
 4. Operation: Non-controlled delivery with theft resistant spindles.
 5. Capacity: Two rolls of up to 6 inch diameter.
 6. Material and Finish: Stainless steel, #4 finish (satin).
- C. **Toilet Tissue Dispenser (TA-2)** at Gypsum Board Walls of Individual Restrooms and Stalls:
1. **Basis of Design:** Bobrick B-6977.
 2. **Mounting:** Recessed.
 3. Description: Double roll dispenser.
 4. Accessible: Yes.
 5. Operation: Non-controlled delivery.
 6. Capacity: Two rolls of up to 5 inch diameter.
 7. Material and Finish: Stainless steel, #4 finish (satin).
- D. **Touchless Soap Dispenser (TA-3):** (OFCI)
1. **Basis of Design:** Bobrick B-826.18 with 826.20 power adapter and one case of 4 bottles.
 2. Power: 120v.
 3. Provide all electrical circuiting back to electrical panel for these units whether or not shown on Drawings.
- E. **Grab Bar, One-Piece (TA-4):**
1. **Basis-of-Design:** Bobrick; B-6897 42" x 54" x 1-1/2".
 2. Mounting: Flanges with concealed fasteners.
 3. Material: Type 304 Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4, satin finish.
 4. Outside Diameter: 1-1/2 inches.
 5. Configuration and Length: 42 x 54 inches, one-piece construction.
- F. **Sanitary-Napkin Disposal Unit (TA-5):**
1. **Basis-of-Design:** Bobrick; B-353 (recessed type at tiled wall conditions); B-254 (surface mounted type at toilet partition conditions)
 2. **Mounting:**
 - a. **Recessed type:** At tiled wall locations.
 - b. **Partition mounted:** At toilet partition locations.
 3. Door or Cover: Self-closing disposal-opening cover and hinged face panel with tumbler lockset.
 4. Receptacle: Removable.
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- G. **Waste Receptacle (TA-6):** (DELETED FROM PROJECT - REPLACE WITH Opti-Serve Hybrid paper towel dispenser (OFCI))
1. **Basis-of-Design:** Bobrick; B-369 with optional 369-130 Towelmate (recessed type) for single user toilets.
 2. Mounting: Recessed 4 inches into cavity.
 3. Capacity: 2 gallons.
 4. Receptacle: Removable.
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
 6. 350 C-Fold Towels or 475 Multi-Fold Towels.

- H. **Combination Paper Towel Dispenser and Waste Receptacle (TA-7) for Public Toilets:** (DELETED FROM PROJECT - REPLACE WITH Opti-Serve Hybrid paper towel dispenser (OFCI))
1. **Basis of Design:** Bobrick B-3947 with optional 369-130 Towelmate.
 2. **Mounting: Recessed type.** Note unit requires 4 inch into cavity.
 3. Capacity:
 - a. Waste: 18 gal.
 - b. Towels: 600 C-fold or 800 multi-fold.
 4. Stainless steel No.4 finish 9 (satin).
- I. **Air Dryers (TA08): (Not Used)**
1. **Basis-of-Design:** Dyson; Airblade dB AB14.
 2. Case: Polycarbonate ABS plastic with antimicrobial coating.
 3. Touch-free operation.
 4. Electrical Characteristics: 120-127V 50 & 60 Hz.
 5. Motor Speed: 92,000 RPM.
 6. **Color:** As selected by Architect.

2.4 OTHER BATHROOM ACCESSORIES

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ameror.
 2. Bobrick Washroom Equipment, Inc.
 3. American Specialties, Inc.
 4. Basco.
 5. Bradley Corporation.
 6. Harneu Hardware.
 7. Taymor.
 8. Freedom Showers
 9. Danze
 10. KR Specialities
 11. Accessible Environments
- B. **Toilet Tissue (Roll) Dispenser (TA-9): (Not Used)**
1. **Basis of Design:** Taymor 01.2608 Satin Stainless Steel.
- C. **Shower Curtain Rod (TA-10): (Not Used)**
1. **Basis-of-Design:** Bobrick; B-207.
 2. Outside Diameter: 1-1/4 inch(32 mm).
 3. Mounting: Flanges with concealed fasteners.
 4. Rod Material and Finish: Stainless steel, No. 4 finish (satin).
 5. Flange Material and Finish: Stainless steel, No. 4 finish (satin).
 6. Accessories: Integral chrome-plated brass glide hooks.
- D. **Double 18" Towel Bar (TA-11): (Not Used)**
1. **Basis-of-Design:** Danze Sirius 18" (3 1/2" x 22") Satin Stainless Steel.
- E. **Robe Hook (TA-12): (Not Used)**
1. **Basis-of-Design:** Bobrick; B-6727.
 2. Description: Double-prong unit.
 3. Material and Finish: Stainless steel, No. 4 finish (satin).
- F. **Single 24" Towel Bar (TA-13): (Not Used)**
1. **Basis of Design:** Taymor 01.2624.
 2. Description: 3/4-inch-(19-mm-) square tube with rectangular end brackets.
 3. Mounting: Flanges with concealed fasteners.
 4. Length: 24 inches.
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- G. **Folding Shower Seat (TA-14): (Not Used)**

1. **Basis-of-Design** Product: Freedom Showers/Accessible Professionals Folding Shower Seat APCSSB-30015PWS White (30" x 15").
 2. Configuration: L-shaped seat, designed for wheelchair access.
 3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect.
 4. Mounting Mechanism: Stainless steel, No. 4 finish (satin).
 5. Dimensions: 30 inches wide by 15 inches deep.
- H. **Shower Curtain and Hooks (TA-15): (Not Used)**
1. Shower Curtain Material: Opaque, matte white vinyl 008" (0.2mm) thick.
 - a. **Basis-of-Design:** Bobrick; B-204-2.
 2. Shower Curtain Hooks Material: Stainless steel.
 - a. **Basis-of-Design:** Bobrick; B-204-1.
 - 1) Substitutions: In accordance with the requirements of Section 012500.
- I. **Baby Changing Station (TA-16): (Not Used)**
1. **Basis-of-Design:** Koala Kare; KB110-SSRE.
 2. Mounting: Recessed type.
 3. Orientation: Horizontal.
 4. Material and Finish: Stainless steel, No. 4 finish (satin).
- J. **Double 24" Towel Bar (TA-17): (Not Used)**
1. **Basis-of-Design:** Danze Sirius 24" (7" x 24") Satin Stainless Steel.
 2. Mounting: Concealed fastener under surface flange.
 3. Length: 24 inches.
 4. Configuration: Double bar.
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- K. **12" Grab Bar (TA-18): (Not Used)**
1. **Basis of Design:** Taymor 01.C220012 Satin Stainless Steel.
- L. **24" Grab Bar (TA-19): (Not Used)**
1. **Basis of Design:** Taymor 01.C220024 Satin Stainless Steel.
- M. **36" Grab Bar (TA-20): (Not Used)**
1. **Basis of Design:** Taymor 01.C220036 Satin Stainless Steel.
- N. **42" Grab Bar (TA-21): (Not Used)**
1. **Basis of Design:** Taymor 01.C220042 Satin Stainless Steel.
- O. **Fold Up Tub Seat (TA-22): (Not Used)**
1. **Basis of Design:** CD Sparling FTB-28; 28"; white.
- P. **Weighted Shower Curtain for Accessible Showers (TA-23):** Accessible Environments # CURT0005-66W x 74H x 72" for 60" shower. Provide with collapsible water dam by KR Specialties model # New Generation 66" with end caps.

2.5 UNDERLAVATORY GUARDS

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Plumberex Specialty Products, Inc.
 2. Truebro, Inc.
- B. **Underlavatory Guard (TA-24): Provide at all exposed hot water piping and drains whether or not indicated on Drawings.**
1. **Basis-of-Design:** Plumberex; Handy-Shield Maxx.
 2. Description: Insulating pipe covering for supply and drain piping assemblies, that prevent direct contact with and burns from piping, and allow service access without removing coverings.
 3. Material and Finish: Antimicrobial, molded-plastic, white.

2.6 CUSTODIAL ACCESSORIES

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bobrick Washroom Equipment, Inc.
 - 2. Bradley Corporation.
- B. **Mop Holder with Shelf (TA-25):**
 - 1. **Basis-of-Design:** Bobrick; B-224x 36
 - 2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
 - 3. Length: 36 inches(914 mm).
 - 4. **Hooks:** Three.
 - 5. **Mop/Broom Holders:** Four, spring-loaded, rubber hat, cam type.
 - 6. Material and Finish: Stainless steel, No. 4 finish (satin).
 - a. **Shelf:** Not less than nominal 0.05-inch-(1.3-mm-) thick stainless steel.
 - b. **Rod:** Approximately 1/4-inch-(6-mm-) diameter stainless steel.

2.7 MIRRORS

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bobrick Washroom Equipment, Inc.
 - 2. Bradley Corporation.
- B. **24 inch wide by 36 inch high (TA-26):**
 - 1. **Basis of Design:** Bobrick B165 2436.
 - 2. Description: Stainless steel channel frame with 1/4 inch thick glass.
 - 3. Set at height meeting ADA requirements.

2.8 FABRICATION

- A. Weld and grind smooth joints of fabricated components.
- B. Form exposed surfaces from single sheet of stock, free of joints.
- C. Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- D. Back paint components where contact is made with building finishes to prevent electrolysis.
- E. Shop assemble components and package complete with anchors and fittings.
- F. Provide steel anchor plates, adapters, and anchor components for installation.
- G. Manufacturer's identification tags or marks are not acceptable on surfaces that will remain exposed to view after installation.
 - 1. Evidence of "patching" after removal of tags or marks is not acceptable.

2.9 FACTORY FINISHING

- A. Galvanizing: ASTM A 123 to 1.25 ounces per square foot.
- B. Chrome/Nickel Plating: ASTM B 456, Type SC 2 polished finish.
- C. **Stainless Steel:** No. 4 satin luster finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. **Examine site conditions to ensure that required blocking, wall thicknesses, and supports are provided prior to ordering units. If wall thicknesses are not sufficient, notify Architect for instruction prior to ordering units. Proceed with Work in accordance with Section 014300.**
- B. Verify that site conditions are ready to receive work and dimensions are as indicated on shop drawings and instructed by the manufacturer.
- C. Check openings for plumbness of blocking and frames.
- D. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site at appropriate time for building-in.
- B. Provide templates and rough-in measurements as required.
- C. Verify exact location of accessories for installation.
- D. Protect adjacent or adjoining finished surfaces and work from damage during installation.

3.3 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturers' printed instructions.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Locate accessories in order that they do not interfere with door swings or use of fixtures. Install recessed accessories after wall finishes have been completed.
- D. Anchor accessories with bolts, plates, and approved type fasteners. Take down any loose items and repair damaged wall surfaces.
- E. Mount surface mounted accessories to backup material with toggle bolts, plumb and align.
- F. Anchor grab bars to drywall with concealed 16 gage steel anchor plates.

3.4 SCHEDULE (refer to Drawings for additional requirements and locations of toilet accessories)

- A. **Public Restrooms:** Provide the following at each Public Restroom:
 - 1. One TA-1 double toilet tissue dispenser at each toilet.
 - 2. One TA-3 touchless soap dispenser at each lavatory.
 - 3. One TA-4 grab bar at each handicapped toilet.
 - 4. One TA-5 sanitary napkin disposal unit for each female toilet.
 - 5. One TA-7 combination paper towel and waste receptacle.
 - 6. One TA-24 undercounter lavatory guard at each lavatory.
 - 7. One trash receptacle adjacent to entry door. Material only allowance of \$80.00 each.
- B. **Individual and Private Restrooms:** Provide the following at each Individual or Private Restroom:
 - 1. One TA-4 grab bar.
 - 2. One TA-3 touchless soap dispenser.
 - 3. One TA-2 toilet tissue dispenser.
 - 4. One TA-7 combination paper towel and waste receptacle.
 - 5. One TA-24 undercounter lavatory guard.
 - 6. One TA-26 24 by 36 inch framed mirror set at an accessible height unless a lighted mirror is called for on RCP's.
 - 7. One trash receptacle adjacent to entry door. Material only allowance of \$80.00 each.
- C. **Janitor Rooms:** Provide two TA-25 mop holders at each Janitor Closet. Place one over mop sink. Refer to drawings for other locations.
- D. **Underlavatory Guards:** Provide TA-24 underlavatory guards at all exposed water pipes and drains below accessible lavatories and sinks.

END OF SECTION

SECTION 104400
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

- A. **Fire extinguishers.**
- B. **Recessed fire extinguisher cabinets.**
- C. **Mounting hardware and accessories.**
- D. **Fire Control Key Box.**

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300.
- B. **Product Data:** Include physical dimensions, operational features, color and finish, anchorage details, material descriptions and type of hardware.
- C. **Shop Drawings:** Include rough-in measurements, locations, and details for cabinets.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 017800.
- B. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain products in this Section from one manufacturer.
- B. Certifications
 - 1. Provide extinguishers which are U.L. listed and bear the U.L. "Listing Work" for type, rating, and classification.
 - 2. Conform to NFPA-10 requirements for extinguishers.
 - 3. Provide units conforming with ANSI/UL 711.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in accordance with Section 016000.
- B. Store extinguishers in protected location until after final cleaning is completed.

1.7 PROJECT/SITE CONDITIONS

- A. Environmental Requirements: Do not store products subject to freeze damage in environments where damage could occur.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Acceptable Manufacturers**
 - 1. Larsens Manufacturing Co.
 - 2. J. L. Industries.
 - 3. Walter Kidde & Co.
 - 4. Note: Larsen's used as a standard of quality in products below where model numbers or styles are indicated.

2.2 FIRE EXTINGUISHERS

- A. **Multi-purpose dry chemical type** U.L. 299, (ammonium phosphate), with pressure gauge. Provide one of the following:
 - 1. **Type A:** MP-10, unless otherwise required by AHJ.
 - 2. **Type B:** If the local fire official determines a larger capacity is required, then provide as required by local AHJ.

2.3 CABINETS

- A. **Cabinet: Basis of Design:** Larsen's model "Occult" series with clear acrylic glazing. Formed sheet stainless steel, 20 gage, **recessed**, size to accommodate accessories.
 - 1. **Type A:** 02409 (6-1/4 inch deep). (Not Used)
 - 2. **Type B:** 03216 (8-1/4 inch deep).
- B. **Trim:** 3/4-inch wide face, stainless steel fully recessed.
- C. **Door: Stainless steel, #4 finish 20 gage thick**, reinforced for flatness and rigidity; latch access.
 - 1. **Glazing:** Clear acrylic.
 - 2. **Style: Vertical Duo Door** with vision panel.
- D. **Mounting Hardware:** Appropriate to cabinet.

2.4 ACCESSORIES

- A. **Fire Extinguisher Surface Mounting Brackets:** Where called for on the Drawings or as otherwise required, provide "B" series full length wall brackets, size as required for cylinder used.

2.5 FIRE CONTROL KEY BOX

- A. Provide one recessed fire department key control box, equal to model 3264 by Knox.
 - 1. Include recessed mounting trim accessories.
 - 2. Determine final location with Fire Marshal.
 - 3. Finish: Clear anodized aluminum.

2.6 FINISHES

- A. **Extinguisher:** Red enamel.
- B. **Cabinet trim and door: Type 304 stainless steel # 4 finish.**

2.7 SCHEDULE

- A. **Provide at all locations as indicated on Drawings and as required by code. Provide and locate such that an FEC is always within 75 ft. of all occupiable space within the building whether or not shown on Drawings.**

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions and proceed with Work in accordance with Section 014300.
- B. Beginning of installation indicates acceptance of existing conditions.

3.2 INSTALLATION

- A. Install using skilled workmen in accordance with manufacturer's printed instructions.
- B. Securely attach cabinets and mounting brackets in place to framed rough opening.
- C. Verify acceptable location, type & size of extinguisher with local fire officials before beginning work.

3.3 IDENTIFICATION

- A. Identify fire extinguisher locations with the following methods
 - 1. **Horizontal silk-screened text turned 90 degrees on stainless steel doors, spelling "FIRE EXTINGUISHER" in red color applied to cabinet door.**

END OF SECTION

SECTION 105123

PLASTIC-LAMINATE-CLAD LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. Section includes plastic-laminate-clad wood lockers.

1.3 SUBMITTALS

- A. **Product Data:** For each type of plastic-laminate-clad wood locker.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker.
- B. **Shop Drawings:** For plastic-laminate-clad wood lockers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Show details full size.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 4. Show locations and sizes of cutouts and holes for items installed in lockers.
 - 5. Show locker fillers, trim, base, sloping tops, and accessories.
 - 6. Show locker numbering sequence.
- C. **Samples for Initial Selection:** For the following:
 - 1. High-pressure decorative laminates.
 - 2. Thermoset decorative overlay panels.
- D. **Samples for Verification:** For the following products:
 - 1. Plastic-laminate-clad panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish, with separate samples of unfaced panel product used for core.
 - 2. Thermoset decorative-overlay-surfaced panels, not less than 8 by 10 inches, for each type, color, pattern, and surface finish.
 - 3. Exposed cabinet hardware and accessories, one unit for each type and finish.
- E. **Maintenance Data:** For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver lockers until painting and similar operations that could damage lockers have been completed in installation areas. If lockers must be stored in other-than-installation areas, store only in areas where environmental conditions are the same as those in final installation location, and comply with requirements specified in "Field Conditions" Article.

1.5 FIELD CONDITIONS

- A. **Environmental Limitations:** Do not deliver or install lockers until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 43 and 70 percent during the remainder of the construction period.
- B. **Field Measurements:** Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support lockers by field measurements before being enclosed, and indicate measurements on Shop Drawings.
- C. **Established Dimensions:** Where lockers are indicated to fit to other construction, establish dimensions for areas where lockers are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.6 WARRANTY

- A. **Special Warranty:** Manufacturer agrees to repair or replace components of lockers that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of locks or hardware.
 - c. Deterioration of wood and other materials beyond normal use.
 2. Warranty Period: **Three years** from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable regulations indicated on the Drawings.

2.2 PLASTIC-LAMINATE-CLAD WOOD LOCKERS

- A. **Construction Style:** Flush overlay.
 1. Reveal Dimension: 1/2 inch.
- B. **Locker Body:** Fabricated from particleboard-core panels covered on both sides with thermoset decorative overlay.
 1. Side Panels: Manufacturer's standard 3/4 or 5/8 inch thick.
 2. Back Panel: Manufacturer's standard 1/2 or 3/8 inch thick.
 3. Top Panel: [Manufacturer's standard 3/4 or 5/8 inch thick.
 4. Bottom Panel: [Manufacturer's standard 3/4 or 5/8 inch thick.
 5. Exposed Panel Edges: 3-mm-thick PVC.
- C. **Plastic-Laminate-Clad Wood Doors:** High-pressure decorative laminate, Grade VGS, over both sides of particleboard core.
 1. Thickness: Manufacturer's standard 3/4 or 5/8 inch thick.
 2. Panel Edges: 3-mm-thick PVC.
- D. **End Panels:** Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- E. **Shelves:** Fabricated from particleboard-core panels covered on both sides with thermoset decorative overlay; fixed.
 1. Thickness: 5/8 inch.
 2. Exposed Edges: 3-mm-thick PVC.
- F. **Drawer Faces:** Match style, material, construction, and finish of plastic-laminate-clad wood doors. Attach drawer faces to subfronts with mounting screws from drawer interior.
- G. **Drawer Subfronts, Sides, and Backs:** Fabricated from particleboard-core panels covered on both sides with thermoset decorative overlay.
 1. Thickness: 3/8 inch.
 2. Exposed Edges: 3 mm thick PVC.
- H. **Drawer Bottoms:** 1/4 inch thick, thermoset decorative overlay over particleboard core.
- I. **Corners and Filler Panels:** 3/4 inch) thick panels. Match style, material, construction, and finish of plastic-laminate-clad wood doors.
- J. **Continuous Finish Base:** Plastic-laminate-clad, 3/4 inch thick panel that matches door faces; fabricated in lengths as long as practical to enclose base and base ends of lockers.
- K. **Plastic-Laminate Colors, Patterns, and Finishes:** As selected by Architect from plastic-laminate manufacturer's full range of colors and patterns.

2.3 MATERIALS

- A. **Composite Wood:** Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
 - 1. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
 - 2. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
- B. **High-Pressure Decorative Laminate:** NEMA LD 3, grades as follows:
 - 1. Horizontal Surfaces: Grade HGL.
 - 2. Vertical Surfaces: Grade HGS.
- C. **Furring, Blocking, Shims, and Hanging Strips:** Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- D. **Anchors:** Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- E. **Wood Support Base:** 2 by 4 inch nominal-size lumber.

2.4 HARDWARE

- A. General: Provide manufacturer's standard locker hardware complying with the requirements in this Section.
- B. **Padlock Hasp:** Surface mounted, steel; finished to match other locker hardware.
- C. **Frameless Hinges (European Type):** Fully concealed, nickel-plated steel, with not less than 125 degrees of opening.
 - 1. Provide three hinges.
- D. **Wire Pulls:** Back mounted; 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.
- E. **Accessible Handle:** Metal, fixed, graspable lever handle and rose trim; surface mounted.
- F. **Hooks:** Manufacturer's standard, ball-pointed aluminum or steel; chrome finished. Attach hooks with at least two fasteners.
 - 1. Provide hooks as indicated on Drawings.
 - 2. Provide one double-prong ceiling hook and two single-prong wall hooks for eRetain one of two "Exposed Hardware Finishes" paragraphs below. First paragraph is manufacturers' standard. See Evaluations.
- G. **Exposed Hardware Finishes:** Polished chrome unless otherwise indicated.

2.5 ACCESSORIES

- A. **Number Plates:** 1-1/2 inch diameter, etched, embossed, or stamped, aluminum plates with black numbers and letters at least 1/2 inch high. Identify lockers in sequence indicated on Drawings. Finish plates to match other locker hardware.

2.6 FABRICATION

- A. **Configuration: Two tier.**
- B. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.
 - 1. Fabricate lockers to dimensions, profiles, and details indicated.
 - 2. Ease edges of corners of solid-wood members to 1/16 inch radius.
- C. Fabricate components square, rigid, without warp, and with finished faces flat and free of scratches and chips. Accurately factory machine components for attachments. Make joints tight and true.
 - 1. Fabricate lockers using manufacturer's standard construction, with joints made with dowels, dados, or rabbets. Dado side panels to receive shelving except where indicated to be adjustable.
- D. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.

2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- E. Venting: Fabricate lockers with space between doors and locker assembly of not less than 1/4 inch.
- F. Number Plates: Inlay number plates flush in each locker door, near top, centered.
- G. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- H. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- I. Attach PVC edging to panels by thermally fusing edging to panels after panel fabrication.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that furring is attached to concrete and masonry walls that are to receive lockers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Condition lockers to average prevailing humidity conditions in installation areas before installation.
- B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

3.3 INSTALLATION

- A. Assemble knocked-down lockers with manufacturer's standard fasteners, with no exposed fasteners on face frames.
- B. Install lockers level, plumb, and true; use concealed shims.
- C. Connect groups of lockers together with manufacturer's standard fasteners, through predrilled holes, with no exposed fasteners on face frames. Fit lockers accurately together to form flush, tight, hairline joints.
- D. Install lockers without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
 1. Installation Tolerance: No more than 1/8 inch in 96 inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.
- E. Locker Anchorage: Fasten wood lockers through back, near top and bottom, at ends with No. 8 flush-head wood screws sized for 1 inch penetration into wood framing, blocking, or furring and spaced not more than 16 inches o.c.
- F. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.
- G. Install number plates after lockers are in place.
 1. Attach number plate on each locker door, near top, centered, with at least two screws with finish matching number plate.

3.4 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean, lubricate, and adjust hardware. Adjust doors to operate easily without binding.
- B. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- C. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION

SECTION 108113
BIRD CONTROL DEVICES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 **SUMMARY**
 - A. **Section Includes:**
 - 1. **Stainless steel bird spikes.**
- 1.3 **SUBMITTALS**
 - A. **Product Data:** Manufacturer's data of product indicated.
- 1.4 PRODUCT DELIVERY
 - A. Deliver materials in factory packages with factory labels attached.
 - B. Cover and protect material in transit and at job site. Damaged or defaced material will be rejected and replaced at no cost to the Owner.

PART 2 - PRODUCTS

- 2.1 **MANUFACTURER**
 - A. **Basis of Design:** Bird-B-Gone; Stainless Steel Pigeon Spikes; width to fit conditions.
- 2.2 **MATERIALS**
 - A. **Plastic Bird Spikes:**
 - 1. Material: Stainless steel.
 - 2. Mounting Method: Non-silicone based construction adhesive.

PART 3 - EXECUTION

- 3.1 EXAMINATION
 - A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - B. Do not proceed until unsatisfactory conditions have been corrected.
- 3.2 INSTALLATION
 - A. Comply with manufacturer's written installation instructions, and specifications unless more stringent requirements are indicated.
 - B. Install to cover entire depth of mounting surface; follow contours and angles closely; cut or break away to fit properly.
- 3.3 **SCHEDULE**
 - A. Provide a minimum of 500 L. F. at locations to be determined with Architect.

END OF SECTION

SECTION 113100

RESIDENTIAL APPLIANCES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 **SECTION INCLUDES**
 - A. **Residential appliances.**
 - B. **All required electrical cords, anchors, and accessories for Residential Appliances**
 - C. **Accessible and Energy Star products.**
- 1.3 SUBMITTALS
 - A. **Product Data:** List model numbers and pertinent performance and size data.
- 1.4 DELIVERY, STORAGE AND HANDLING
 - A. Deliver, store, and handle material in accordance with Section 016000.
 - B. Keep materials in original packing until final installation and hook up.
 - C. Do not deliver to site until immediately prior to installation, or as otherwise approved by Owner.

PART 2 - PRODUCTS

- 2.1 **MANUFACTURERS**
 - A. **Basis-of-Design:** General Electric unless otherwise noted below.
 - B. **Note: All products shall be Energy Star and ADA compliant.**
- 2.2 ELECTRICAL REQUIREMENTS
 - A. Fabricate and assemble products in strict conformity with the requirements of the Underwriter's Laboratories, Inc.
 - B. Provide under and over voltage protection.
 - C. Each item shall bear the appropriate label of the Underwriter's Laboratories, Inc.
- 2.3 **APPLIANCES**
 - A. **Refrigerator / Freezer (Top Freezer) with Ice Maker (ADA Compliant):**
 - 1. **Basis of Design:** GE; Model No. GIE21GSHSS.
 - 2. Capacity: 21.2 cu. ft.
 - 3. Finish: Stainless steel
 - B. **Electric Range with cooktop: (Not Used)**
 - 1. **Basis of Design:** GE; Model No. JS630SFSS.
 - 2. Burner Type: Smooth radiant.
 - C. **Dishwasher (ADA Compliant):**
 - 1. **Basis of Design:** Asko; D5426XL.
 - 2. Tub: Stainless steel.
 - 3. Seven spray wash system, convection dry, 50 dBA.
 - 4. Finish: Stainless steel.
 - 5. Size: approximately 32" x 23" x 22"
 - D. **Countertop Microwave Oven (Loose equipment):**
 - 1. **Basis of Design:** GE; Model No. PEB7226SFSS.
 - 2. Capacity: 2.2 cu. ft.
 - 3. Size: approximately 24" x 14" x 20"

- E. **Undercounter Microwave Oven: (Not Used)**
 - 1. **Basis of Design:** GE; Model No. PVM9179SFSS.
 - 2. **Capacity:** 1 cu. ft.
- F. **Undercounter Refrigerator: (Not Used)**
 - 1. **Basis of Design:** N/A
- G. **Washing Machine (Front Loading Model, ADA Compliant):**
 - 1. **Basis of Design:** GE; Model No. GFW480SSKWW (ADA Compliant).
 - 2. **Capacity:** 4.9 cu. Ft
 - 3. **Color:** White
 - 4. **Size:** approximately 28" x 39" x 34"
- H. **Dryer (Front Loading Model, ADA Compliant):**
 - 1. **Basis of Design:** GE; Model No. GFD48ESSKWW.
 - 2. **Capacity:** 8.3 cu. ft.
 - 3. **Color:** White
 - 4. **Size:** approximately 28" x 39" x 34"

PART 3 - EXECUTION

- 3.1 **PREPARATION**
 - A. Verify that built-in and finish work is complete and ready for appliance installation.
 - B. Verify electrical and plumbing requirements are correct.
 - C. Verify openings for built-in items are correct.
 - D. Beginning of installation indicates acceptance of existing conditions.
 - E. Provide anti-tip devices on ranges.
- 3.2 **INSTALLATION**
 - A. Install all items in locations indicated and/or as directed.
 - B. Provide competent foreman as supervisor for the installation, and to coordinate with other trades in regard to connections and installations.
 - C. Kitchen equipment shall be installed, tested and adjusted by skilled mechanics.
 - D. Complete all required connections to units in accordance with applicable codes.
- 3.3 **CLEAN UP/START-UP**
 - A. Remove all debris and wipe down all appliances.
 - B. Start-up and run all units through one complete cycle to ensure proper operation. Adjust as required. Replace any malfunctioning equipment prior to substantial completion.
- 3.4 **SCHEDULE**
 - A. Contractor shall provide and install each of the following pieces of Residential Appliances on the Project.
 - 1. **Student Lounge 140**
 - a. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - b. (1) Dishwasher (ADA)
 - c. (1) Countertop Microwave
 - 2. **Laundry 141**
 - a. (1) Washing Machine (ADA)
 - b. (1) Dryer (ADA)
 - 3. **Break Room 211**
 - a. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - b. (1) Dishwasher (ADA)
 - c. (1) Countertop Microwave
 - 4. **Break Room 307**
 - d. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - e. (1) Dishwasher (ADA)

- f. (1) Countertop Microwave
- 5. **Kitchenette 413**
 - g. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - h. (1) Countertop Microwave
- 6. **Break Room 424**
 - i. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - j. (1) Dishwasher (ADA)
 - k. (1) Countertop Microwave
- 7. **Break Room 433**
 - l. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - m. (1) Dishwasher (ADA)
 - n. (1) Countertop Microwave
- 8. **Break Room 443**
 - o. (1) Full Size Refrigerator with Top Freezer with Ice Maker (ADA)
 - p. (1) Dishwasher (ADA)
 - q. (1) Countertop Microwave

END OF SECTION

SECTION 117300
PATIENT CARE EQUIPMENT

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.2 **SUMMARY**
 - A. **Section Includes:** Patient care equipment.
- 1.3 **PREINSTALLATION MEETINGS**
 - A. Preinstallation Conference: Conduct conference at Project site.
- 1.4 **SUBMITTALS**
 - A. **Product Data:** Manufacturer's data of product indicated.
 - B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of components. Indicate location and size of each field connection.
 - 3. Include diagrams for service connections and power, signal, and control wiring.
 - C. **Operation and Maintenance Data:** For products to include in operation and maintenance manuals.
- 1.5 **PRODUCT DELIVERY**
 - A. Deliver materials in factory packages with factory labels attached.
 - B. Cover and protect material in transit and at job site. Damaged or defaced material will be rejected and replaced at no cost to the Owner.

PART 2 - PRODUCTS

- 2.1 **MANUFACTURER**
 - A. Basis of Design:
 - 1. **Horizontal Headwall:** Modular Services Co.; Single Tier Silhouette III, Model 8510.
 - 2. **Vertical Headwall:** Modular Services Co.; Dual Single Sided Extended Profile Unit, Model 7112.
 - 3. **Twin Articulating Arm Headwall:** Dual Stratus Series 5830; Model 5832-D.
 - 4. **Single Articulating Arm Headwall:** Stratus Series 5830, Model 5832.
 - 5. **Bed Docker:** Modular Services Co.; BD601.
- 2.2 **PATIENT-BED LOCATORS**
 - A. Bed Docker: Surface-mounted docking station with conduit raceway provisions for eight power-service connections, four on each side, that is UL listed and labeled and complying with NFPA 70, and that ensures proper positioning of patient beds and protects wall surfaces from impact and abrasion damage caused by contact with patient bed.
- 2.3 **PATIENT-BED HEADWALLS**
 - A. Patient-Bed HeadWall: Headwall system; UL listed and labeled; complying with NFPA 70 and NFPA 99; with integrated raceways that provide single-area connection for power services and communication wiring and single connection for hard-piped and brazed medical gas piping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions, and specifications unless more stringent requirements are indicated.
- B. Patient-Bed Dockers:
 - 1. Install bed dockers level and plumb, according to manufacturer's written instructions.
 - 2. Accurately fit, align, securely fasten, and install bed dockers free from distortion or defects.
- C. Patient-Bed Headwalls:
 - 1. Install service walls level and plumb, according to manufacturer's written instructions.
 - 2. Accurately fit, align, securely fasten, and install service walls free from distortion or defects.

3.3 PROTECTION

- A. Protect installed products from damage for the remainder of the construction period.
- B. Repair damaged products according to manufacturer's written instructions. If damaged products cannot be successfully repaired, as determined by Architect, remove and replace damaged products.

3.4 SCHEDULE

A. Base Bid:

- 1. 201A - Nursing Sim #1: Stratus Series 5830.
- 2. 201B - Nursing Sim #2: Stratus Series 5830.
- 3. 201C - Nursing Sim #3: Stratus Series 5830.
- 4. 201D - Nursing Sim #4: Dual Single Sided Extended Profile Unit, Model 7112 with Bed Docker BD601.
- 5. 260 - IPE Sim: Stratus Series 5830.
- 6. 255A - R. C. Sim #1: Dual Single Sided Extended Profile Unit, Model 7112.
- 7. 255B - R. C. Sim #1: Dual Single Sided Extended Profile Unit, Model 7112.
- 8. 360A - Skills Bed #9: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
- 9. 360B - Skills Bed #10: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
- 10. 360C - Skills Bed #11: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
- 11. 360D - Skills Bed #12: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
- 12. 360E - Skills Bed #13: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.

B. Alternate #4:

- 1. 201E - Nursing Sim #5: Dual Single Sided Extended Profile Unit, Model 7112 with Bed Docker BD601.
- 2. 201F - Nursing Sim #6: Dual Single Sided Extended Profile Unit, Model 7112 with Bed Docker BD601.
- 3. 201G - Nursing Sim #7: Dual Single Sided Extended Profile Unit, Model 7112 with Bed Docker BD601.
- 4. 201H - Nursing Sim #8: Dual Single Sided Extended Profile Unit, Model 7112 with Bed Docker BD601.
- 5. 250A - R. C. Sim #1: Single Tier Silhouette III, Model 8510.
- 6. 250B - R. C. Sim #1: Single Tier Silhouette III, Model 8510.
- 7. 250C - R. C. Sim #1: Single Tier Silhouette III, Model 8510.
- 8. 250D - R. C. Sim #1: Single Tier Silhouette III, Model 8510.
- 9. 255C - R. C. Sim #1: Dual Single Sided Extended Profile Unit, Model 7112.
- 10. 255D - R. C. Sim #1: Dual Single Sided Extended Profile Unit, Model 7112.

11. 305 - Clinic: Single Tier Silhouette III, Model 8510.
12. 306 - Clinic: Single Tier Silhouette III, Model 8510.
13. 350A - Skills Bed #1: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
14. 350B - Skills Bed #2: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
15. 350C - Skills Bed #3: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
16. 350D - Skills Bed #4: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
17. 350E - Skills Bed #5: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
18. 350F - Skills Bed #6: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
19. 350G - Skills Bed #7: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
20. 350H - Skills Bed #8: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
21. 360F - Skills Bed #14: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
22. 360G - Skills Bed #15: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.
23. 360H - Skills Bed #16: Single Tier Silhouette III, Model 8510 with Bed Docker BD601.

END OF SECTION

SECTION 122413

ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. **Section Includes:**
 - 1. **Manual roller shades**
 - 2. **Motorized shade operators.**
 - 3. **Blackout Roller Shades (Not used).**

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 007013 and Section 013100.
- B. **Product Data:** For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.
 - 1. **Manual Shade Operators.**
 - 2. **Motorized Shade Operators:** Include operating instructions.
 - 3. **Motors:** Show nameplate data, ratings, characteristics, and mounting arrangements.
- C. **Shop Drawings:** Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.
 - 1. **Manual Shade Operators:** Elevate and schedule each window shade size, shape and location within the building using same room number designations used on drawings.
 - 2. **Motorized Shade Operators:** Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 - 3. **Wiring Diagrams:** Power, system, and control wiring.
- D. **Coordination Drawings:** Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension system members and attachment to building structure.
 - 2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
 - 3. Shade mounting assembly and attachment.
 - 4. Size and location of access to shade operator, motor, and adjustable components.
 - 5. Minimum Drawing Scale: 1/4 inch = 1 foot (1:48).
- E. **Samples for Initial Selection:** For each colored component of each type of shade indicated.
 - 1. Include similar Samples of accessories involving color selection.
- F. **Samples for Verification:**
 - 1. **Complete, full-size operating unit** not less than 16 inches wide for each type of roller shade indicated.
 - 2. **For the following products:**
 - a. **Shade Material For Initial Selection:** Not less than 3 inches square, with specified treatments applied for all manufacturer's complete line of products, for Architect's initial selection. Mark face of material.
 - b. **Shade Material:** Not less than three 12-inch-square sections of fabric selected by the Architect for the project, from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.

- G. **Maintenance Data:** For roller shades to include in maintenance manuals. Include the following:
1. Methods for maintaining roller shades and finishes.
 2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
 3. Operating hardware.
 4. Motorized shade operator.

1.4 **QUALITY ASSURANCE**

- A. **Installer Qualifications:** Approved by Fabricator of products, with **10 years experience installing specified products.**
- B. **Source Limitations:** Obtain roller shades through one source from a single manufacturer.
- C. **Fire-Test-Response Characteristics:** Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. Flame-Resistance Ratings: Passes NFPA 701.
- D. **Product Standard:** Provide roller shades complying with WCMA A 100.1.
- E. **Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.**
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 2. Do not purchase remainder of shade fabric until approval of mock-up has been received.

1.5 **DELIVERY, STORAGE, AND HANDLING**

- A. Deliver shades in factory packages, marked with manufacturer and product name, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.6 **PROJECT CONDITIONS**

- A. **Environmental Limitations:** Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. **Field Measurements:** Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 **EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. **Rollers Shades:** Provide extra fabric shade replacements for each size, color, texture, and pattern indicated in full-size units equal to a minimum of 2 percent of the amount installed.

PART 2 - PRODUCTS

2.1 **ROLLER SHADES**

- A. **Basis of Design:**
1. **Manufacturer:** MechoShade Systems, Inc.
 2. **Manual Operation:** Mecho/5, single shade.
 3. **Motorized Operation:** Electro/3, single shade.
- B. **Acceptable Manufacturers:** Subject to compliance with Basis of Design requirements above, other manufacturers products that may be incorporated into the Work include, but are not

limited to, the following:

1. Draper Inc.
 2. Hunter Douglas Contract.
 3. Lutron Electronics Co., Inc.
 4. MechoShade Systems, Inc.
 5. Nysan Solar Control Inc.; Hunter Douglas Company.
 6. Silent Gliss USA, Inc.
- C. **Shade Band Material:** PVC-coated fiberglass.
1. **Pattern, Style, Color, Screening Percentage:** To be selected by Architect from manufacturer's full and complete line of products.
 2. **Bottom Hem:** Straight.
- D. **Rollers:** Electro-galvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide capacity for two roller shade band(s) per roller, unless otherwise indicated on Drawings.
- E. **Direction of Roll:** Regular, from back of roller.
- F. **Mounting Brackets:** Fascia end caps, fabricated from steel finished to match fascia or headbox.
- G. **Fascia:** L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated; removable design for access.
- H. **Top/Back Cover:** L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.
- I. **Bottom Bar:** Steel or extruded aluminum, with plastic or metal capped ends. Provide-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.
- J. **Audiovisual Light-Blocking (Blackout) Shades (Not Used):** Designed for eliminating all visible light gaps when shades are fully closed; fabricated from blackout shade band material with fascia headbox pocket and bottom bar extended and formed for light-tight joints among shade components and between shade components and adjacent construction.
1. **Side Channels, Sill Channel or Angle, and Perimeter Seals:** Manufacturer's standard design, including sill light seal attached to bottom bar, for eliminating light gaps when shades are closed.
 2. **Shade Band Retention System:** Manufacturer's standard design for guiding shade band material through range of travel and holding shade band flat with edges of material within side channels.
- K. **Mounting:** Recessed in ceiling above windows (confirm final mounting type in the field on mock-up with Architect).
- L. **Hold-Down Brackets and Hooks or Pins:** Manufacturer's standard for fixing shade in place, keeping shade band material taut, and reducing light gaps when shades are closed.
- M. **Shade Operation: Manual;** with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.
1. **Pull:** Manufacturer's standard hand-grip engaged pull.
 2. **Clutch:** Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
 3. **Lift-Assist Mechanism:** Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
 4. **Loop Length:** Length required to make operation convenient from floor level.
 5. **Bead Chain:** Nickel-plated metal or stainless steel.

2.2 ROLLER SHADE FABRICATION

- A. **Product Description:** Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

- B. **Concealed Components:** Non-corrodible or corrosion-resistant-coated materials.
 - 1. Lifting Mechanism: With permanently lubricated moving parts.
- C. **Unit Sizes:** Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. **Shade Units Installed between (Inside) Jambs or Mullions:** Edge of shade not more than 1/8 inch from face of jamb or mullion. Length equal to head to sill dimension of opening in which each shade is installed.
 - 2. **Shade Units Installed Outside Jambs:** Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- D. **Installation Brackets:** Designed for easy removal and reinstallation of shade, for supporting fascia, headbox, roller, and operating hardware and for hardware position and shade mounting method indicated.
- E. **Installation Fasteners:** No fewer than two fasteners per bracket, fabricated from metal non-corrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.
- F. **Color-Coated Finish:** For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
- G. **Colors of Metal and Plastic Components Exposed to View:** As selected by Architect from manufacturer's full and complete line of products. Refer to Document 008900, Finish Selection Summary.

2.3 **MOTORIZED ROLLER SHADE OPERATORS**

- A. **Acceptable Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Manufacturer of manual operation roller shade.
 - 2. Elero USA Inc.
 - 3. SIMU US, Inc.
 - 4. SOMFY Systems.
- B. **General:** Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with the building electrical system.
- C. Comply with NFPA 70.
- D. **Control Equipment:** Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6[with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc].
- E. **Electric Motors:** UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.
 - 1. **Service Factor:** According to NEMA MG 1, unless otherwise indicated.
 - 2. **Motor Characteristics:** Single phase, 110 V, 60 Hz.
 - 3. **Motor Mounting:** Within manufacturer's standard roller enclosure.
- F. **Position of Motor and Electrical Connection:** Left side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated on Drawings.
- G. **Remote Controls:** Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following devices for remote-control activation of shades:
 - 1. **Control Stations:** Keyed, -contact, three-position, switch-operated control station with

- open, close, and off functions. Provide two keys per station.
2. **Individual/Group Control Stations:** Momentary-contact, three-position, rocker-style, wall switch-operated control station with open, close, and center off functions for individual and group control.
 - a. **Color:** Bright White.
 - b. **Product:** Subject to compliance with requirements, provide "**Decora Plus**" by **Leviton Manufacturing Co. Inc.** or equal.
 - H. **Limit Switches:** Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.
 - I. **Operating Function:** Stop and hold shade at any position.
 - J. **Operating Features:** Include the following:
 1. Group switching with integrated switch control; single face plate for multiple switch cut-outs.
 - K. **Power / Circuiting:** Provide electrical power/circuitry from a panel approved by the electrical engineer, to provide a complete and total system whether or not power/circuitry is shown on the Drawings.
 - L. Program and provide relay required to connect to hand-held touch screen control device used in Council Chambers and Executive Council Room.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades between window mullions, level, plumb, and aligned with adjacent units according to manufacturer's written instructions. Locate so shade band is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades. Refer to Division 01 Section Demonstration and Training."

3.6 SCHEDULE

- A. **Manual Roller Shades with Solar Shade Fabric:** Refer to locations called for in Section 008900 - Finish Selections Summary.
- B. **Motorized Roller Shades with Solar Shade Fabric:** Refer to locations called for in Section 008900 - Finish Selections Summary.
- C. **Roller Shades with Blackout Fabric (Not Used)**

END OF SECTION

SECTION 123640

QUARTZ AGGLOMERATE COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section includes quartz agglomerate countertops.**

1.3 SUBMITTALS

- A. **Product Data:** For each accessory and manufactured product.
- B. **Shop Drawings:**
 - 1. Include plans, sections, details, and attachments to other work.
 - 2. Show locations and details of joints.
 - 3. Show direction of veining, grain, or other directional pattern.
- C. **Samples for Verification:** For each quartz agglomerate type indicated, in sets of Samples not less than 12 inches square.
 - 1. Include three or more Samples in each set and show the full range of variations in appearance characteristics expected in the completed Work.
- D. **Maintenance Data:** For quartz countertops to include in maintenance manuals. Include product data for care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

1.4 QUALITY ASSURANCE

- A. **Fabricator Qualifications:** Shop that employs skilled workers who custom-fabricate quartz countertops similar to that required for this Project, and whose products have a record of a **minimum of 10 years successful in-service performance with specified product.**
- B. **Installer Qualifications:** Fabricator of quartz countertops with a **minimum 10 years successful experience fabricating and installing specified products.**
- C. **Mockups:** Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle quartz and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
 - 1. Lift quartz with wide-belt slings; do not use wire rope or ropes that might cause staining. Move quartz agglomerate, if required, using dollies with cushioned wood supports.
 - 2. Store quartz on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to quartz agglomerate. Ventilate under covers to prevent condensation.

1.6 FIELD CONDITIONS

- A. **Field Measurements:** Verify dimensions of construction to receive quartz countertops by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Source Limitations:** Obtain quartz from a single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 QUARTZ AGGLOMERATE COUNTERTOP MATERIALS

- A. **Quartz Agglomerate:** Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with ICPA SS-1, except for composition.
 - 1. **Colors and Patterns:** As indicated in Document 008900 - Finish Selection Summary.

2.3 COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. **Grade:** Premium.
- B. **Configuration:**
 - 1. **Front:** 1-1/2 inch laminated bullnose.
 - 2. **Backsplash:** Straight.
 - 3. **End Splash:** Match backsplash.
- C. **Countertops:** 3 cm thick, quartz agglomerate laminated to 3/4 inch thick plywood substrate (marine grade at wet locations).
- D. **Backsplashes:** 2 cm thick, quartz agglomerate.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. **Joints:** Fabricate countertops without joints.
- G. **Cutouts and Holes:**
 - 1. **Undercounter Plumbing Fixtures:** Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
 - c. Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.
 - 2. **Counter-Mounted Plumbing Fixtures:** Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. **Fittings:** Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
 - 4. **Counter-Mounted Cooktops (Not Used):** Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive quartz agglomerate countertops and conditions under which quartz agglomerate countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of quartz agglomerate countertops.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of quartz agglomerate countertops.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by quartz agglomerate countertop Installer for anchoring quartz agglomerate countertops. Furnish installers of other work with Drawings or templates showing locations of these items.
- B. Before installing quartz agglomerate countertops, clean dirty or stained quartz agglomerate surfaces by removing soil, stains, and foreign materials. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives and rinse with clear water. Allow quartz agglomerate to dry before installing.

3.3 CONSTRUCTION TOLERANCES

- A. **Variation from Level:** Do not exceed 1/8 inch in 96 inches, 1/4 inch maximum.
- B. **Variation in Joint Width:** Do not vary joint thickness more than one-fourth of nominal joint width.
- C. **Variation in Plane at Joints (Lipping):** Do not exceed 1/64 inch difference between planes of adjacent units.
- D. **Variation in Line of Edge at Joints (Lipping):** Do not exceed 1/64 inch difference between edges of adjacent units, where edge line continues across joint.

3.4 INSTALLATION OF COUNTERTOPS

- A. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- B. Install countertops over subtops with full spread of water-cleanable epoxy adhesive.
- C. Install countertops by adhering to supports with water-cleanable epoxy adhesive.
- D. Do not cut quartz agglomerate in field unless otherwise indicated. If quartz agglomerate countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.
- E. Do necessary field cutting as quartz agglomerate is set. Use power saws with diamond blades to cut quartz agglomerate. Cut lines straight, true, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- F. Set quartz agglomerate to comply with requirements indicated. Shim and adjust quartz agglomerate to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances. Install anchors and other attachments indicated or necessary to secure quartz agglomerate countertops in place.
- G. Bond joints with quartz agglomerate adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in quartz agglomerate edges at joints. Fill kerfs with quartz agglomerate adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- H. Space joints with 1/16 inch gap for filling with sealant. Use temporary shims to ensure uniform spacing.
 - 1. Install metal splines in kerfs in quartz agglomerate edges at joints. Fill kerfs with setting adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- I. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut quartz agglomerate. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- J. Install backsplashes and end splashes by adhering to countertops with quartz agglomerate adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

Leave 1/16 inch gap between splashes and wall for filling with sealant. Use temporary shims to ensure uniform spacing.

- K. Install backsplashes and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave 1/16 inch gap between countertop and splashes for filling with sealant. Use temporary shims to ensure uniform spacing.
- L. Grout joints to comply with ANSI A108.10. Remove temporary shims before grouting. Tool grout uniformly and smoothly with plastic tool.
- M. Apply sealant to joints and gaps specified for filling with sealant; comply with Section 079200 "Joint Sealants." Remove temporary shims before applying sealant.

3.5 ADJUSTING AND CLEANING

- A. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
- B. Remove and replace quartz agglomerate countertops of the following description:
 - 1. Broken, chipped, stained, or otherwise damaged quartz agglomerate. Quartz agglomerate may be repaired if methods and results are approved by Architect.
 - 2. Defective countertops.
 - 3. Defective joints, including misaligned joints.
 - 4. Interior quartz agglomerate countertops and joints not matching approved Samples and mockups.
 - 5. Interior quartz agglomerate countertops not complying with other requirements indicated.
- C. Replace in a manner that results in quartz agglomerate countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.
- D. Clean quartz agglomerate countertops no fewer than six days after completion of sealant installation, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that may damage quartz agglomerate.
- E. Sealer Application: Apply quartz agglomerate sealer to comply with quartz agglomerate producer's and sealer manufacturer's written instructions.

3.6 SCHEDULE

- A. Provide quartz countertops, vertical trim and backsplashes at the following locations:
 - 1. Reception desks at Nursing Department offices at 4th floor and Dental Hygiene at 1st floor.
 - 2. Dental Operatories in Dental Hygiene.
 - 3. Countertops at all Breakrooms and Nursing Stations in Labs.
 - 4. Dental Hygiene Locker Room countertops.
 - 5. Window sills throughout (2 cm).
 - 6. Refer to Drawings and finish plans for additional locations.

END OF SECTION

SECTION 123646

SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions established within General and Supplementary Conditions of the Contract, Division 01 - General Requirements, and the Drawings are collectively applicable to this Section.

1.2 SUMMARY

- A. **Section includes solid surfacing countertops.**

1.3 SUBMITTALS

- A. **Product Data:** For each accessory and manufactured product.
- B. **Shop Drawings:**
 - 1. Include plans, sections, details, and attachments to other work.
 - 2. Show locations and details of joints.
 - 3. Show direction of veining, grain, or other directional pattern.
- C. **Samples for Verification:** For each solid surfacing type indicated, in sets of Samples not less than 12 inches square.
 - 1. Include three or more Samples in each set and show the full range of variations in appearance characteristics expected in the completed Work.
- D. **Maintenance Data:** For solid surfacing countertops to include in maintenance manuals. Include product data for care products used or recommended by Installer, and names, addresses, and telephone numbers of local sources for products.

1.4 QUALITY ASSURANCE

- A. **Fabricator Qualifications:** Shop that employs skilled workers who custom-fabricate solid surfacing similar to that required for this Project, and whose products have a record of a **minimum of 10 years successful in-service performance with specified product.**
- B. **Installer Qualifications:** Fabricator of solid surfacing countertops with a **minimum 10 years successful experience fabricating and installing specified products.**
- C. **Mockups:** Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle solid surfacing and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
 - 1. Lift solid surfacing with wide-belt slings; do not use wire rope or ropes that might cause staining. Move solid surfacing, if required, using dollies with cushioned wood supports.
 - 2. Store solid surfacing on wood A-frames or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to solid surfacing. Ventilate under covers to prevent condensation.

1.6 FIELD CONDITIONS

- A. **Field Measurements:** Verify dimensions of construction to receive solid surfacing countertops by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. **Solid Surface Material:** Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Type: Provide veneer type.
 - 2. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
 - 3. **Colors and Patterns:** As indicated in Document 008900 - Finish Selection Summary.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surfacing manufacturer's written instructions and the AWI/AWMA/WI's "Architectural Woodwork Standards."
 - 1. **Grade:** Premium.
- B. **Configuration:**
 - 1. **Front:** 1-1/2 inch laminated bullnose.
 - 2. **Backsplash:** Straight.
 - 3. **End Splash:** Match backsplash.
- C. **Countertops:** 3 cm thick, solid surfacing laminated to 3/4 inch thick plywood substrate (marine grade at wet locations).
- D. **Backsplashes:** 2 cm thick, solid surfacing.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surfacing manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. **Joints:** Fabricate countertops without joints.
- G. **Cutouts and Holes:**
 - 1. **Undercounter Plumbing Fixtures:** Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch (5 mm) into fixture opening.
 - b. Provide vertical edges, rounded to 3/8-inch (10-mm) radius at juncture of cutout edges with top surface of countertop, slightly eased at bottom, and projecting 3/16 inch (5 mm) into fixture opening.
 - c. Provide 3/4-inch (20-mm) full bullnose edges projecting 3/8 inch (10 mm) into fixture opening.
 - 2. **Counter-Mounted Plumbing Fixtures:** Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - 3. **Fittings:** Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.
 - 4. **Counter-Mounted Cooktops (Not Used):** Prepare countertops in shop for field cutting openings for cooktops. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surfacing countertops and conditions under which solid surfacing countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of solid surfacing countertops.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of solid surfacing countertops.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by solid surfacing countertop Installer for anchoring solid surfacing countertops. Furnish installers of other work with Drawings or templates showing locations of these items.
- B. Before installing solid surfacing countertops, clean dirty or stained solid surfacing surfaces by removing soil, stains, and foreign materials. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives and rinse with clear water. Allow solid surfacing to dry before installing.

3.3 CONSTRUCTION TOLERANCES

- A. **Variation from Level:** Do not exceed 1/8 inch in 96 inches, 1/4 inch maximum.
- B. **Variation in Joint Width:** Do not vary joint thickness more than one-fourth of nominal joint width.
- C. **Variation in Plane at Joints (Lipping):** Do not exceed 1/64 inch difference between planes of adjacent units.
- D. **Variation in Line of Edge at Joints (Lipping):** Do not exceed 1/64 inch difference between edges of adjacent units, where edge line continues across joint.

3.4 INSTALLATION OF COUNTERTOPS

- A. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- B. Install countertops over subtops with full spread of water-cleanable epoxy adhesive.
- C. Install countertops by adhering to supports with water-cleanable epoxy adhesive.
- D. Do not cut solid surfacing in field unless otherwise indicated. If solid surfacing countertops or splashes require additional fabrication not specified to be performed at Project site, return to fabrication shop for adjustment.
- E. Do necessary field cutting as solid surfacing is set. Use power saws with diamond blades to cut solid surfacing. Cut lines straight, true, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- F. Set solid surfacing to comply with requirements indicated. Shim and adjust solid surfacing to locations indicated, with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances. Install anchors and other attachments indicated or necessary to secure solid surfacing countertops in place.
- G. Bond joints with solid surfacing adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in solid surfacing edges at joints. Fill kerfs with solid surfacing adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- H. Space joints with 1/16 inch gap for filling with sealant. Use temporary shims to ensure uniform spacing.
 - 1. Install metal splines in kerfs in solid surfacing edges at joints. Fill kerfs with setting adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- I. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Use power saws with diamond blades to cut solid surfacing. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- J. Install backsplashes and end splashes by adhering to countertops with solid surfacing adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Leave 1/16 inch gap between splashes and wall for filling with sealant. Use temporary shims to ensure uniform spacing.

- K. Install backsplashes and end splashes by adhering to wall with water-cleanable epoxy adhesive. Leave 1/16 inch gap between countertop and splashes for filling with sealant. Use temporary shims to ensure uniform spacing.
- L. Grout joints to comply with ANSI A108.10. Remove temporary shims before grouting. Tool grout uniformly and smoothly with plastic tool.
- M. Apply sealant to joints and gaps specified for filling with sealant; comply with Section 079200 "Joint Sealants." Remove temporary shims before applying sealant.

3.5 ADJUSTING AND CLEANING

- A. In-Progress Cleaning: Clean countertops as work progresses. Remove adhesive, grout, mortar, and sealant smears immediately.
- B. Remove and replace solid surfacing countertops of the following description:
 - 1. Broken, chipped, stained, or otherwise damaged solid surfacing. Solid surfacing may be repaired if methods and results are approved by Architect.
 - 2. Defective countertops.
 - 3. Defective joints, including misaligned joints.
 - 4. Interior solid surfacing countertops and joints not matching approved Samples and mockups.
 - 5. Interior solid surfacing countertops not complying with other requirements indicated.
- C. Replace in a manner that results in solid surfacing countertops matching approved Samples and mockups, complying with other requirements, and showing no evidence of replacement.
- D. Clean solid surfacing countertops no fewer than six days after completion of sealant installation, using clean water and soft rags. Do not use wire brushes, acid-type cleaning agents, cleaning compounds with caustic or harsh fillers, or other materials or methods that may damage solid surfacing.
- E. Sealer Application: Apply solid surfacing sealer to comply with solid surfacing producer's and sealer manufacturer's written instructions.

END OF SECTION

SECTION 102123

CUBICLE CURTAINS AND TRACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBMITTALS

- A. **Product Data:** Submit manufacturer's specifications to evidence compliance with these specifications.
- B. **Shop Drawings:**
 - 1. Show details of the system, related construction and reflected layout of ceiling areas showing location of tracks in relation to other ceiling mounted items.
 - 2. Indicate materials, finishes, dimensions, thicknesses and/or gages of parts, reinforcement, where applicable, and anchorage including items of hardware and accessories necessary for complete installation.
- C. **Samples for Verification:**
 - 1. Curtain: Full size sample.
 - 2. Track: 12 inch long track with end caps and curtain carriers.
- D. **Cubicle Schedule:** Use same room designations as indicated on Drawings.
- E. **Maintenance Data:** For inclusion in maintenance manual required by Division 01.
 - 1. Include manufacturer's instructions for maintenance of installed Work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
 - 2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.3 MAINTENANCE

- A. **Extra Materials:** Furnish as described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Curtain Carriers: Full-size units equal to 3 percent of amount installed for each size indicated.
 - 2. Curtains: Two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Refer to **Section 008900 - Finish Selections Summary**.
- B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers named alphabetically below. If not named, submit as substitution according to Conditions of the Contract and appropriate Division 01 Sections.
 - 1. AR Nelson Co.
 - 2. Construction Specialties, Inc.
 - 3. Imperial Fastener Co.
 - 4. In Pro Corp.
 - 5. Salsbury Industries.

2.2 CUBICLE CURTAINS

- A. **Curtain Fabric:** Product that is equivalent to color, texture, pattern, finish, appearance, and material quality characteristics indicated by basis of design selection.
- B. **Curtain Construction:**

1. Flame Resistance: Comply with NFPA 701.
2. **Curtain Top:** Not less than 20 inch wide nylon mesh with 1/2 inch holes; overlap seams and double-lock stitch to body of curtain.
3. **Width:** Equal to track length plus 10 percent.
4. **Length:** Equal to floor-to-ceiling height minus 20 inches from finished ceiling at top and 12 to 15 inches above finished floor.
5. **Top Hem:** Not less than 1 inch and not more than 1-1/2 inch wide, triple thickness, reinforced with integral web and double stitched; 2 piece, rolled edge, corrosion resistant, nickel-plated brass grommets spaced not more than 6 inches on centers.
6. **Bottom and Side Hems:** Not less than 1 inch wide, reinforced, triple thickness and single stitched.
7. **Seams:** Not less than 1/2 inch wide, double turned and double stitched.

2.3 CURTAIN TRACKS

- A. **Extruded-Aluminum Track:** Not less than 1-1/4 inches wide by 3/4 inch high, with minimum wall thickness of 0.058 inch.
 1. Curved Track: Factory fabricated 12 inch radius bends.
 2. Finish: Clear anodized.
- B. **Track Accessories:** Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
- C. **Curtain Carriers:** Two nylon rollers and nylon axle with chrome-plated steel, stainless steel, or aluminum hook with nickel plated steel beaded chain curtain drop.
- D. **Exposed Fasteners:** Stainless steel.
- E. **Concealed Fasteners:** Hot-dip galvanized.

2.4 IV SUPPORT SYSTEMS

- A. **Extruded-Aluminum IV Track:** Not less than 1-1/4 inches wide by 3/4 inch high; with minimum wall thickness of 0.058 inch.
 1. Curved Track: Factory fabricated 12 inch radius bends.
 2. Finish: Clear anodized.
- B. **IV Carriers:** Four nylon rollers and steel or stainless-steel axles, with hanger loop fabricated from 1/4-inch- diameter stainless steel.
- C. **Telescoping IV Hangers:** 3/4 inch stainless-steel main shaft and a 3/8 inch stainless-steel inner shaft, vertically adjustable 16 inches; with 4 non folding 1/4 inch stainless-steel arms with loops and a stainless-steel top loop to attach to carrier.

PART 3 - EXECUTION

- A. Acceptance of Surfaces and Conditions:
 1. Examine substrates to which cubicle specialties will be applied for compliance with requirements and other conditions affecting performance.
 2. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
 3. Starting Work within a particular area will be construed as acceptance of surface conditions.

3.2 INSTALLATION

- A. Installation Quality Standards: In addition to standards listed elsewhere, perform work according to following, unless otherwise specified:
 1. Respective manufacturer's installation instructions.
 2. Approved submittals.
 3. Contract Documents.

- B. General: Install tracks level and plumb, according to manufacturer's written instructions. Provide track fabricated from one continuous length up to 16 feet.
 - 1. Curtain Track Mounting: Surface.
 - 2. IV Track Mounting: Surface.
- C. Surface Track Mounting: Fasten surface-mounted tracks at intervals of not less than 24 inches. Fasten support at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Mechanically fasten to suspended ceiling grid with screws.
- D. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- E. IV Hangers: Unless otherwise indicated, install one IV hook on each IV track and hang one IV hanger.
- F. Curtain Carriers: Provide curtain carriers adequate for 6 inch spacing along the full length of the curtain plus an additional carrier.

END OF SECTION

SECTION 134900

RADIATION PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lead sheet, strip, and plate.
2. Lead-lined building materials and products including the following:
 - a. Gypsum board.
 - b. Steel hollow-metal door frames.
 - c. Wood doors.
 - d. Leaded glass.
3. Informational signs.

1.3 DEFINITIONS

- A. **Lead Equivalence:** The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.
 1. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

1.4 SUBMITTALS

- A. **Product Data:** For each type of product indicated. Include detailed technical product information and installation instructions.
- B. **Shop Drawings:** Show layout of radiation-protected areas. Indicate lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.
 1. Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Engage an experienced installer who has completed work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance **for over 10 years**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide materials and workmanship, including joints and fasteners, which maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.
 1. Materials, thicknesses, and configurations indicated are based on radiation protection design prepared by Owner's radiation health physicist. This design is available to Contractor on request.

- B. **Lead-Lined Assemblies:** Unless otherwise indicated, provide lead thickness in doors, door frames, window frames, penetration shielding, joint strips, film transfer cabinets, and other items located in lead-lined assemblies not less than that indicated for assemblies in which they are installed.

2.2 MATERIALS

- A. **Lead Sheet, Strip, and Plate:** ASTM B 749, alloy UNS No. L51121 (chemical-copper lead).
 - 1. **Thickness:** 1/16 inch.
- B. **Lead-Lined Gypsum Board:** 5/8 in thick Type X gypsum board complying with Division 09 Section "Gypsum Board Assemblies," of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.
 - 1. Provide lead sheet lining the full width and to 7'-0" high on board.
 - 2. Provide 3 in wide lead strips for wrapping metal stud flanges.
 - 3. Provide 2 in wide lead strips for backing joints.
 - 4. Provide 5/16 in lead disks for covering screw heads.
- C. **Lead Glass:** Lead-barium, polished glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.
 - 1. **Safety Glass:** **Tempered lead glass.**
- D. **Accessories and Fasteners:** Provide manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.

2.3 LEAD-LINED, OBSERVATION-WINDOW FRAMES

- A. **General:** Fabricate from 0.043 inch thick, formed-steel sheet or 0.064 inch thick aluminum extrusions with mitered corners, welded or bolted with concealed fasteners.
 - 1. Line with lead sheet formed to match frame contour, continuous in each jamb and across head and sill, lapping the stops, and fabricated wide enough to maintain an effective lap with lead of adjoining assemblies.
 - 2. Construct so lead lining overlaps glazing material perimeter by at least 3/8 inch and furnish removable stops.
 - 3. Form sill with an opening for sound transmission. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

2.4 LEAD-LINED WOOD DOORS

- A. **Lead-Lined Wood Doors:** Flush wood doors complying with Division 08 Section "Flush Wood Doors" with lead lining of thickness not less than that required for walls in which they are located.

2.5 INFORMATIONAL SIGNS

- A. **Informational Signs, General:** Fabricate signs by engraving lettering in high-pressure-laminate engraving stock with contrasting face and core. Machine engrave copy using high-speed cutters mechanically positioned by master templates for accurately formed letters, numbers, and symbols.
 - 1. **Color:** As selected by Architect from manufacturer's full range of colors.
 - 2. Provide copy indicated or as directed. Provide signs of sufficient size to contain required information.
 - 3. Indicate lead equivalence in millimeters and heights of radiation protection in inches (millimeters).
- B. **Rooms Where the Level of Protection Is Uniform Throughout:** Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.
- C. **Rooms Where the Level of Protection Is Not Uniform Throughout:** Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation

protection above floor or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.

- D. **Rooms Where Some Partitions Are without Radiation Protection:** Provide one sign for each partition that contains radiation protection and indicate its lead equivalence. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.
- E. **Rooms Where Only the Door Has Radiation Protection:** Provide one sign for each door indicating its lead equivalence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates in areas to receive radiation protection, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LEAD-LINED GYPSUM BOARD

- A. Install with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints.
- B. Fastening to Metal Supports: Use steel drill screws spaced as recommended in writing by gypsum board manufacturer. Install lead strips covering face of framing and wrap around flange to cover points of screws.
 - 1. Where possible, install lead-lined gypsum board before installing gypsum board on other side of partition, and do not fold lead strips back over inside of flange until after lead-lined gypsum board is applied.
 - 2. Apply lead disks recessed flush with surface of board over heads of screws securing trim.
- C. Openings: Extend lead-lined gypsum board into frames of openings, lapping lead lining with lead frames or frame linings at least 1 in. Arrange board around openings so neither horizontal nor vertical joints occur at corners of openings.
- D. Install control and expansion joints where indicated, with appropriate trim accessories. Install lead strip on face of framing, extending across joint, and lap with lead lining of gypsum board.

3.3 INSTALLATION OF LEAD-LINED DOORS AND DOOR FRAMES

- A. Install lead-lined steel door frames according to Division 08 Section "Hollow Metal Doors and Frames."
- B. Install lead-lined wood doors according to Division 08 Section "Flush Wood Doors."
- C. Lap lead lining of frames over lining in walls at least 1 in.
- D. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. See Division 08 Section "Door Hardware" for other installation requirements.
- E. Touch up damaged finishes with compatible coating after sanding smooth.
- F. Operation: Rehang or replace doors that do not swing or operate freely. Check and readjust operating hardware items, leaving doors and frames undamaged and in proper operating condition.

3.4 INSTALLATION OF PENETRATING ITEMS

- A. At penetrations of lead linings, provide lead shields to maintain continuity of protection.
- B. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.
- C. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.
- D. Film Transfer Cabinets: Where film transfer cabinets occur in lead-lined partitions, line wall flange with lead sheet of same thickness as required for partition where it is located.

- E. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 1 in. Wrap conduit with lead sheet for a distance of not less than 10 in from box.
- F. Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to three times the largest opening dimension. Lap lead sheet with adjacent lead lining at least 1 in.
- G. Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than 10 in from point of penetration.

3.5 FIELD QUALITY CONTROL

- A. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.
- B. Additional inspections, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- C. Testing: After radiology equipment has been installed and placed in operating condition, Owner will engage a radiation health physicist to test radiation protection.
- D. Make corrections required by radiation health physicist.
- E. Uncover and repair or replace defective work, including finishes and other work covering defective work. Arrange and pay for additional testing by radiation health physicist until no more corrections are required.

3.6 PROTECTION

- A. Lock radiation-protected rooms once doors and locks are installed and limit access to only those persons performing work in the rooms.

END OF SECTION

SECTION 142400
HYDRAULIC ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydraulic passenger elevators.

B. Related Requirements:

1. Section 011000 "Summary" for purchase contract for elevators negotiated by Owner and assigned to Contractor.
2. Section 015000 "Temporary Facilities and Controls" for temporary use of elevators for construction purposes.
3. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
4. Section 051200 "Structural Steel Framing" for the following:
 - a. Attachment plates, angle brackets, and other structural-steel preparations for fastening guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills that are part of steel frame.
5. Section 055000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Divider beams.
 - c. Hoist beams.
 - d. Structural-steel shapes for subsills.
 - e. Pit ladders.
 - f. Cants made from steel sheet in hoistways.
6. Section 055213 "Pipe and Tube Railings" for railings between adjacent elevator pits.
7. Section 008900, Finish Selection Summary for finish flooring in elevator cars.
8. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
9. Section 312000 "Earth Moving" for excavating well hole to accommodate cylinder assembly and for the disposition of excavated material from the cylinder well hole.

1.3 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

- B. Service Elevator: A passenger elevator that is also used to carry freight.

1.4 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
 - 2. Include large-scale layout of car-control station.
 - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.
- C. Samples for Initial Selection: For finishes involving color selection.
- D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes, **3-inch- (75-mm-)** square Samples of sheet materials and **4-inch (100-mm)** lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Manufacturer Certificates: Signed by elevator manufacturer, certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 - 1. Submit manufacturer's/installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44 **including diagnostic and repair information available to manufacturer's and installer's maintenance personnel.**

- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
- D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner with terms, conditions, and obligations as set forth in, and in same form as, "Draft of Elevator Maintenance Agreement" at end of this Section, starting on date initial maintenance service is concluded.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer **or an authorized representative who is trained and approved by manufacturer and who has at least ten (10) years experience.**

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Furnish well casing and coordinate delivery with related excavation work.
- C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HYDRAULIC ELEVATOR MANUFACTURERS

- A. Thyssen Krupp, ENDURA B 5000H
- B. Source Limitations: Obtain elevators from single manufacturer.
 - 1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with Section 407 in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

2.3 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description:
 - 1. Elevator Number(s): 1 and 2.
 - 2. Type: Under-the-car single cylinder.
 - 3. Rated Load: **5000 lb (2270 kg)**.
 - 4. Rated Speed: **175 fpm (0.89 m/s) in up direction, 200 fpm (1.0 m/s) in down direction**.
 - 5. Operation System: **Group automatic operation**.
 - 6. Auxiliary Operations:
 - a. Battery-powered lowering.
 - b. Automatic operation of lights and ventilation fans.
 - c. Independent service for **all cars in group**.
 - 7. Car Enclosures:
 - a. Inside Width: **68 inches (1727 mm)** from side wall to side wall.
 - b. Inside Depth: **108 inches (2743 mm)** from back wall to front wall (return panels).
 - c. Inside Height: Not less than **100 inches** to underside of ceiling.
 - d. Front Walls (Return Panels): **Satin stainless steel, No. 4 finish** with integral car door frames.
 - e. Car Fixtures: **Satin stainless steel, No. 4 finish**.
 - f. Side and Rear Wall Panels: **Satin stainless steel, No. 4 finish**.
 - g. Reveals: **Satin stainless steel, No. 4 finish**.
 - h. Door Faces (Interior): **Satin stainless steel, No. 4 finish**.
 - i. Door Sills: **Aluminum**.
 - j. Ceiling: **Brushed stainless steel**.
 - k. Handrails: **1-1/2 inches (38 mm) round**, at [sides] [and] [rear] of car.
 - l. Floor: 3/8" Resinous Matrix Terrazzo, by flooring sub-contractor.

- m. Floor prepared to receive carpet (specified in Section 096816 "Sheet Carpeting").
 - n. Floor prepared to receive resilient flooring (specified in Section 096500 "Resilient Flooring").
 - o. Floor recessed and prepared to receive [**dimension stone tile (specified in Section 093033 "Stone Tiling")**] [**ceramic tile (specified in Section 093013 "Ceramic Tiling")**].
 - p. Floor Thickness, Including Setting Materials: 3/8" recess above plywood subfloor.
8. Hoistway Entrances:
- a. Width: **54 inches (1372 mm)**.
 - b. Height: 96 **inches (2134 mm)**.
 - c. Type: **Two-speed side sliding**
 - d. Frames **Satin stainless steel, No. 4 finish** Plastic-laminate doors are about as expensive as stainless-steel doors but are not as durable.
 - e. Doors: **Satin stainless steel, No. 4 finish**
 - f. Sills: **Aluminum**.
9. Hall Fixtures **Satin stainless steel, No. 4 finish**
10. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from **satin stainless steel, No. 4**.
 - b. Provide hooks for protective pads in **all cars** and **one** complete set(s) of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
 - 1. Pump shall be **submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts**.
 - 2. Motor shall have **solid-state** starting.
 - 3. Motor shall have variable-voltage, variable-frequency control.
- B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
 - 1. Cylinder units shall be connected with dielectric couplings.
 - 2. Casing for Underground Piping: Schedule 40 PVC pipe complying with ASTM D 1785, joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.
- D. Hydraulic Fluid: Elevator manufacturer's standard **fire-resistant** fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
- E. Hydraulic Fluid: Nontoxic, biodegradable, **fire-resistant** fluid, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives, that is approved by elevator manufacturer for use with elevator equipment. Oil Type: Readily biodegradable that is

USDA certified biobased product, ultra low toxicity, readily biodegradable, energy efficient, high performing fluid made from canola oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives. Especially formulated for operating in environmentally sensitive areas. USDA certified biobased product, 95% bio-based content, per ASTM D6866.

- F. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- G. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1/CSA B44, of sufficient size to provide not less than **1-inch (25-mm)** clearance from cylinder and extending above pit floor. Casing shall have means of monitoring effectiveness to comply with ASME A17.1/CSA B44.
- H. Car Frame and Platform: Welded[**or bolted**] steel units.
- I. Guides: **Roller guides**. Provide guides at top and bottom of car frame.

2.5 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
 - 1. Group Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
 - 2. Group Battery-Powered Lowering: When power fails, cars are lowered to the lowest floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
 - 3. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.
 - 4. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls[**and predetermined weight**] can be adjusted.
 - 5. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
 - 6. Off-Peak Operation: During periods of low traffic, half of the elevators in a group shall be taken out of service and switched to low-power mode.
 - 7. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.
 - 8. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-energized before car doors open.

2.6 DOOR-REOPENING DEVICES

- A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door-reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

- A. General: Provide **steel-framed car enclosures with nonremoveable** wall panels, with **removable** car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 - 1. Subfloor: Exterior, underlayment-grade plywood, not less than **5/8-inch (15.9-mm)** nominal thickness.
 - 2. Floor Finish: 3/8" **Resinous Matrix Terrazzo** by flooring sub-contractor
 - 3. Stainless-Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless-steel sheet.
 - 4. Fabricate car with recesses and cutouts for signal equipment.
 - 5. Fabricate car door frame integrally with front wall of car.
 - 6. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated **from stainless-steel sheet**.
 - 7. Sight Guards: Provide sight guards on car doors.
 - 8. Sills: Extruded aluminum.
 - 9. **Metal** Ceiling: Flush panels, with LED down lights in the center of each panel. **Align ceiling panel joints with joints between wall panels.**
 - 10. Light Fixture Efficiency: Not less than 35 lumens/W.
 - 11. Ventilation Fan Efficiency: Not less than **3.0 cfm/W (1.4 L/s per W)**.

2.8 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.
 - 1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to **NFPA 252**.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 - 1. Stainless-Steel Frames: Formed from stainless-steel sheet.
 - 2. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated **from stainless-steel sheet**.
 - 3. Sight Guards: Provide sight guards on doors matching door edges.
 - 4. Sills: Extruded aluminum.

2.9 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide **vandal-resistant** buttons and lighted elements illuminated with LEDs.
- B. Swing-Return Car-Control Stations: Provide car-control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
 - 1. Mark buttons and switches for function. Use both tactile symbols and Braille.
 - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in car control station, with identification, instructions for use, and battery backup power supply.
- D. Car Position Indicator: Provide **illuminated**, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- E. Hall Push-Button Stations: **Provide one hall push-button station at each landing**
 - 1. Provide **vandal resistant units with flat faceplate for mounting with body of unit recessed in wall.**
 - 2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
- F. Traditional Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide the following:
 - 1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
- G. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 - 1. At manufacturer's option, audible signals may be placed on cars.

2.10 FINISH MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 441.
- D. Stainless-Steel Bars: ASTM A 276, Type 441.
- E. Stainless-Steel Tubing: ASTM A 554, Grade MT 441.

- F. Aluminum Extrusions: **ASTM B 221** (**ASTM B 221M**), Alloy 6063.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Excavation for Cylinder: Drill well hole in[**each**] elevator pit to accommodate installation of cylinder; comply with applicable requirements in Section 312000 "Earth Moving."
- B. Provide **waterproof** well casing **as necessary** to retain well-hole walls.
- C. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole **and provide permanent waterproof seal at bottom of well casing**.
 - 1. Align cylinder and fill space around protective casing with fine sand.
- D. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between **well protective** casing and pit floor with **4 inches (100 mm)** of nonshrink, nonmetallic grout.
- E. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
- F. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- G. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- H. Install piping above the floor, where possible. Install underground piping in casing.
 - 1. Excavate for piping and backfill encased piping according to applicable requirements in Section 312000 "Earth Moving."
- I. Lubricate operating parts of systems as recommended by manufacturers.

- J. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- K. Leveling Tolerance: **1/4 inch (6 mm)**, up or down, regardless of load and travel direction.
- L. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- M. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
 - 2. Place hall lanterns either above or beside each hoistway entrance.
 - 3. Mount hall lanterns at a minimum of **72 inches (1829 mm)** above finished floor.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: **Limit temporary use for construction purposes to one elevator.** Comply with the following requirements for **each** elevator used for construction purposes:
 - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 - 2. Provide strippable protective film on entrance and car doors and frames.
 - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 - 5. Do not load elevators beyond their rated weight capacity.
 - 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 - 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, **adjust, and maintain** elevator(s).

- B. Check operation of **each** elevator with Owner's personnel present before date of Substantial Completion **and again not more than one month before end of warranty period**. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Perform maintenance during normal working hours.
 - 2. Perform emergency callback service during normal working hours with response time of **two** hours or less.
 - 3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of **two** hours or less.

END OF SECTION 142400

SECTION 211000

WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following fire-suppression piping inside the building:
 - 1. Automatic wet-type, Class I standpipe systems.
 - 2. Automatic dry-type, Class I standpipe systems.
 - 3. Manual dry-type, Class I standpipe systems.
 - 4. Wet-pipe sprinkler systems.
 - 5. Dry-pipe sprinkler systems.
 - 6. Preaction sprinkler systems.
- B. Related Sections include the following:
 - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
 - 2. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and pump controllers.
 - 3. Division 21 Section "Clean-Agent Fire Extinguishing Systems" for extinguishing systems.
 - 4. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.
 - 5. Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. Underground Service-Entrance Piping: Underground service piping below the building.

1.3 SYSTEM DESCRIPTIONS

- A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.
- B. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
- C. Automatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
- D. Manual Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Does not have permanent water supply. Piping is dry. Water must be pumped into standpipes to satisfy demand.

- E. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- F. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.
- G. Pre-action Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.

1.4 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.
 - 1. Minimum residual pressure at each hose-connection outlet is the following:
 - a. NPS 2-1/2 Hose Connections: 100 psig.
 - 2. Unless otherwise indicated, the following is maximum residual pressure at required flow at each hose-connection outlet:
 - a. NPS 2-1/2 Hose Connections: 175 psig.
- C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications shall be in accordance with the latest edition of NFPA 13.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design: Per NFPA 13
 - 4. Minimum Density for Deluge-Sprinkler Piping Design: Per NFPA 13
 - 5. Maximum Protection Area per Sprinkler: Per NFPA 13
 - 6. Total Combined Hose-Stream Demand Requirement: Per NFPA 13

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Piping materials, including dielectric fittings, flexible connections, and sprinkler specialty fittings.
 - 2. Pipe hangers and supports.
 - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
 - 4. Air compressors, including electrical data.
 - 5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
 - 6. Hose connections, including size, type, and finish.

7. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
 8. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
 - C. Fire-hydrant flow test report.
 - D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
 - E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
 - F. Welding certificates.
 - G. Field quality-control test reports.
 - H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.
 - I. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series number.
 - J. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
 1. NFPA 13, "Installation of Sprinkler Systems."
 2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
 3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
- D. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.
- B. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.
 - 1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Victaulic Co. of America.
 - 2) Anvil International.
 - b. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
 - c. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, synthetic rubber gasket with center leg, and steel bolts and nuts.
 - d. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, cast with offsetting, angle-pattern bolt pads, synthetic rubber gasket with center leg, listed for use with housing, and steel bolts and nuts.
 - e. Grooved-End Transition Flange: UL 213, gasketed fitting with key for ductile-iron-pipe dimensions. Include flange-type, ductile-iron housing with synthetic rubber gasket listed for use with housing and steel bolts and nuts.

2.2 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
 - 1. Cast-Iron Threaded Flanges: ASME B16.1.
 - 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 - 3. Gray-Iron Threaded Fittings: ASME B16.4.
 - 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 5. Steel Threaded Couplings: ASTM A 865.
- B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.
 - 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, roll-grooved ends.
 - 1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) TYCO
 - 3) Victaulic Co. of America.
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD or ASTM A 53 forged or fabricated from carbon steel pipe with factory grooved ends designed to accept grooved mechanical couplings from the same manufacturer.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, synthetic rubber gasket listed for use with housing, and steel bolts and nuts.
 - 1) Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.
 - a) 1-1/4" through 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts.
 - b) 5" and larger: Standard rigid coupling.
 - 2) Flexible Type: Use in seismic areas where required by NFPA 13.
 - a) 2" through 8": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts.
 - b) 10" and larger: Standard flexible coupling.

- d. Grooved-End-Pipe Flange Adapters: UL213 and AWWA C606, steel pipe OD dimensions, ASTM A536 ductile iron housing, flat faced, designed for incorporating flanged components with ANSI Class 125 bolt-hole patterns to a grooved piping system.
- D. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 5 and smaller; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.
 - 1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
 - 2. Steel Flanges and Flanged Fittings: ASME B16.5.
- E. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 4 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10; with factory- or field-formed, roll-grooved ends.
 - 1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) TYCO
 - 3) Victaulic Co. of America.
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD or ASTM A 53 forged or fabricated from carbon steel pipe with factory grooved ends designed to accept grooved mechanical couplings from the same manufacturer.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.
 - 1) Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.
 - a) 1-1/4" through 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts.
 - b) 5" and larger: Standard rigid coupling.
 - 2) Flexible Type: Use in seismic areas where required by NFPA 13.
 - a) 2" through 8": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts.
 - b) 10" and larger: Standard flexible coupling.
 - d. Grooved-End-Pipe Flange Adapters: UL213 and AWWA C606, steel pipe OD dimensions, ASTM A536 ductile iron housing, flat faced, designed for incorporating flanged components with ANSI Class 125 bolt-hole patterns to a grooved piping system.

2.3 DIELECTRIC FITTINGS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
- B. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.
- C. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 deg F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
- D. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
- E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225 deg F.
- F. Dielectric Nipples: Electroplated steel or ductile iron with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 230 deg F.

2.4 FLEXIBLE CONNECTORS

- A. Flexible connectors shall have materials suitable for system fluid. Include [175-psig minimum] [250-psig minimum] working-pressure rating and ends according to the following:
 - 1. NPS 2 and Smaller: Threaded.
 - 2. NPS 2-1/2 and Larger: Flanged.
 - 3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
- B. Manufacturers:
 - 1. Flexhead Industries, Inc.
 - 2. Flexicraft Industries.
 - 3. Flex-Pression, Ltd.
 - 4. Proco Products, Inc.
 - 5. Unaflex Inc.
- C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.5 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

- A. Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.6 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 300-psig working-pressure rating if fittings are components of high-pressure piping system.

- B. Outlet Specialty Fittings:

- 1. Manufacturers:

- a. Anvil International, Inc.
 - b. TYCO
 - c. Victaulic Co. of America.

- 2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with locating collar to ensure proper installation, synthetic rubber gaskets, bolts and nuts, and threaded or grooved outlets.

- 3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

- C. Sprinkler Drain and Alarm Test Fittings: Bronze, Cast- or ductile-iron body; with threaded or grooved inlet and outlet, test valve, and orifice and sight glass.

- 1. Manufacturers:

- a. TYCO
 - b. Fire-End and Croker Corp.
 - c. Viking Corp.
 - d. Victaulic Co. of America.

- D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

- 1. Manufacturers:

- a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire-End and Croker Corp.
 - c. Potter-Roemer; Fire-Protection Div.

- E. Sprinkler Inspector's Test Fitting: Bronze, Cast- or ductile-iron housing with threaded or grooved inlet and drain outlet and sight glass.

- 1. Manufacturers:

- a. AGF Manufacturing Co.
 - b. TYCO
 - c. G/J Innovations, Inc.
 - d. Triple R Specialty of Ajax, Inc.

- e. Victaulic Company
- F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
 - 1. Manufacturers:
 - a. CECA, LLC.
 - b. Merit.
- G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.
- H. Flexible, Sprinkler Hose Fittings:
 - 1. Manufacturers:
 - a. Fivalco Inc.
 - b. FlexHead Industries, Inc.
 - c. Gateway Tubing, Inc.
 - d. Victaulic AquaFlex
 - 2. Standard: UL 2443.
 - 3. Type: Braided or unbraided, multiple-use stainless steel Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 4. Pressure Rating: [175 psig minimum] [300 psig].
 - 5. Size: Same as connected piping, for sprinkler.

2.7 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 300-psig pressure rating if valves are components of high-pressure piping system.
- B. Gate Valves with Wall Indicator Posts:
 - 1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
 - 2. Gate Valves: UL 262, ductile-iron body, bronze mounted, EPDM coated cast iron disc, brass stem, grooved ends, with horizontal-wall type, or upright post indicator.
 - 3. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with operating wrench or hand wheel, extension rod, locking device, and cast-iron barrel.
 - 4. Manufacturers:
 - a. Grinnell Fire Protection.
 - b. McWane, Inc.; Kennedy Valve Div.
 - c. NIBCO.
 - d. Stockham.
 - e. Victaulic Company.
- C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
 - 1. NPS 1-1/2 and Smaller: Bronze body with threaded or grooved ends.
 - 2. NPS 2 and NPS 2-1/2: Bronze body with threaded or grooved ends or ductile-iron body with grooved ends.
 - 3. Manufacturers:

- a. NIBCO.
- b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

- 1. NPS 3 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends. Weather-proof actuator with pre-wired supervisory switches monitoring the valve in the open or closed positions. Maximum 365 psig (2517 kPa) working pressure.

- a. Manufacturers:

- 1) TYCO
- 2) Global Safety Products, Inc.
- 3) McWane, Inc.; Kennedy Valve Div.
- 4) Mueller Company.
- 5) NIBCO.
- 6) Pratt, Henry Company.
- 7) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron or ductile-iron body with flanged or grooved ends. Up to 365 psig (2517 kPa) maximum working pressure.

- 1. Manufacturers:

- a. TYCO
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Globe Fire Sprinkler Corporation.
- d. Grinnell Fire Protection.
- e. Mueller Company.
- f. NIBCO.
- g. Potter-Roemer; Fire Protection Div.
- h. Reliable Automatic Sprinkler Co., Inc.
- i. Stockham.
- j. Victaulic Co. of America.
- k. Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.

- 1. NPS 2 and Smaller: Bronze body with threaded ends.

- a. Manufacturers:

- 1) Crane Co.; Crane Valve Group; Crane Valves.
- 2) NIBCO.

- 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

- a. Manufacturers:

- 1) Crane Co.; Crane Valve Group; Crane Valves.
- 2) Milwaukee Valve Company.
- 3) Mueller Company.
- 4) NIBCO.
- 5) Victaulic Company.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch, Electrical, 115-V ac, prewired, 2-circuit, supervisory switch, Visual.
2. NPS 2-1/2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a. Manufacturers:

- 1) Milwaukee Valve Company.
- 2) NIBCO.
- 3) Victaulic Co. of America.

3. NPS 3 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

- 1) TYCO
- 2) Grinnell Fire Protection.
- 3) Milwaukee Valve Company.
- 4) NIBCO.
- 5) Victaulic Co. of America.

2.8 BACKFLOW PREVENTERS

A. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers:

- a. Conbraco Industries, Inc.
- b. FEBCO; SPX Valves & Controls.
- c. Watts Industries, Inc.; Water Products Div.
- d. Zurn Plumbing Products Group.

2. Standard: ASSE 1015.

3. Operation: Continuous-pressure applications, unless otherwise indicated.

4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or steel with interior lining complying with AWWA C550 for NPS 2-1/2 and larger.

6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

7. Configuration: Designed for horizontal, straight through flow.

8. Accessories:

- a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

B. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:

1. Manufacturers:

- a. Conbraco Industries, Inc.

- b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group.
 - 2. Standard: ASSE 1047 and FMG approved or UL listed.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
 - 5. Body: Cast iron with interior lining complying with AWWA C550 or Steel with interior lining complying with AWWA C550.
 - 6. End Connections: Flanged.
 - 7. Configuration: Designed for horizontal, straight through flow.
 - 8. Accessories:
 - a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
 - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- C. Double-Check, Detector-Assembly Backflow Preventers:
- 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1048 and FMG approved or UL listed.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 - 5. Body: Cast iron with interior lining complying with AWWA C550 or Steel with interior lining complying with AWWA C550.
 - 6. End Connections: Flanged.
 - 7. Configuration: Designed for horizontal, straight through flow.
 - 8. Accessories:
 - a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.9 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 300-psig pressure rating if valves are components of high-pressure piping system.
- 1. Manufacturers:
 - a. TYCO
 - b. Globe Fire Sprinkler Corporation.
 - c. Grinnell Fire Protection.
 - d. Reliable Automatic Sprinkler Co., Inc.
 - e. Victaulic Co. of America.
 - f. Viking Corp.

2. Alarm Check Valves: UL 193, designed for vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer. Valve internal components shall be replaceable without removing the valve from the installed position.
 - a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
3. Dry-Pipe Valves: UL 260, differential type; with bronze or brass seat with Nitrile O-ring seals, single-hinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment. Minimum required air pressure is 13 psi with low pressure actuator and 300 psig maximum water pressure rating in all sizes. Valve internal components shall be replaceable without removing the valve from the installed position and shall be externally resettable. Valve shall be supplied completely assembled with shutoff valve, pre-set pressure switches and drain kit.
 - a. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.
 - 1) Manufacturers:
 - a) TYCO
 - b) Gast Manufacturing, Inc.
 - c) Grinnell Fire Protection.
 - d) Reliable Automatic Sprinkler Co., Inc.
 - e) Viking Corp.
 - f) Victaulic Company
 - b. Air Compressor/Air Maintenance Assembly: Consisting of a riser mounted compressor, air maintenance device, and flexible hoses for installation. Assemble shall be designed to ensure operational air pressure within 30 minutes of discharge.
4. Pre-Action Valves: UL 260, low differential, latched clapper design, with black enamel coated ductile iron body, tapped for main drain and all available trim configurations, aluminum bronze clapper with synthetic rubber seat, stainless steel spring and shaft, brass seat and Nitrile seat o-rings. Valve internal parts shall be replaceable without removing the valve from the installed position and shall be externally resettable. Maximum water pressure is 300 psig in all sizes and minimum required air pressure is 13 psig with low pressure actuator for pneumatic activation or solenoid valve for electrical activation. Valve shall have grooved ends for vertical installation. Separate check valve downstream is not required.
 - a. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.
 - 1) Manufacturers:
 - a) TYCO
 - b) Gast Manufacturing, Inc.
 - c) Grinnell Fire Protection.
 - d) Reliable Automatic Sprinkler Co., Inc.
 - e) Viking Corp.
 - f) Victaulic Company

- B. Pressure-Regulating Valves: UL 1468, brass or bronze, NPS 1-1/2 and NPS 2-1/2, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.
 - 1. Finish: Rough metal.
 - 2. Manufacturers:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire-End and Croker Corp.
 - c. GMR International Equipment Corporation.
 - d. Grinnell Fire Protection.
 - e. Potter-Roemer; Fire Protection Div.
 - f. Zurn Industries, Inc.; Wilkins Div.
- C. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
 - 1. Manufacturers:
 - a. AFAC Inc.
 - b. Grinnell Fire Protection.

2.10 SPRINKLERS

- A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Sprinklers shall have [300-psig] pressure rating if sprinklers are components of high-pressure piping system.
- B. Manufacturers:
 - 1. TYCO
 - 2. Reliable Automatic Sprinkler Co., Inc.
 - 3. Victaulic Co. of America.
 - 4. Viking Corp.
- C. Automatic Sprinklers: With heat-responsive element complying with the following:
 - 1. UL 199, for nonresidential applications.
 - 2. UL 1767, for early-suppression, fast-response applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
 - 1. All Sprinklers shall be Quick Response.
- E. Sprinkler types, features, and options as follows:
 - 1. Concealed ceiling sprinklers, including cover plate.
 - 2. Extended-coverage sprinklers.
 - 3. Flush ceiling sprinklers, including escutcheon.
 - 4. High-pressure sprinklers.
 - 5. Institution sprinklers, made with a small, breakaway projection.
 - 6. Pendent sprinklers.
 - 7. Pendent, dry-type sprinklers.
 - 8. Quick-response sprinklers.

9. Recessed sprinklers, including escutcheon.
10. Sidewall sprinklers.
11. Sidewall, dry-type sprinklers.
12. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Corrosion-resistant paint or Nickel-Teflon.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.

2.11 FIRE HOSE VALVES

A. Manufacturers:

1. Elkhart Brass Mfg. Co., Inc.
2. Croker Corp.
3. Guardian Fire Equipment Incorporated.
4. McWane, Inc.; Kennedy Valve Div.
5. Mueller Company.
6. Potter-Roemer; Fire-Protection Div.

B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. NPS 2-1/2 by NPS 1-1/2 reducer adapter and hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: Nonadjustable type, unless pressure-regulating type is required.
2. Finish: Rough metal or chrome-plated.

2.12 FIRE VALVE CABINETS

A. Manufacturers:

1. Elkhart Brass Mfg. Co., Inc.
2. Croker Corp.
3. Grinnell Fire Protection.
4. Guardian Fire Equipment Incorporated.
5. McWane, Inc.; Kennedy Valve Div.
6. Mueller Company.
7. Potter-Roemer; Fire-Protection Div.

B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle pattern design; female NPS inlet and male hose outlet; and

lugged cap, gasket, and chain. NPS 2-1/2 by NPS 1-1/2 reducer adapter and hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: Nonadjustable type, unless pressure-regulating type is required.
 2. Finish: Rough metal or chrome-plated.
 3. Mountings: Pipe escutcheon for cabinet-mounted units.
- C. Recessed mounted valve cabinet of 20 ga. Steel. Refer to architect for door and finish requirements. Cabinet must be large enough to accommodate hose valve indicated.

2.13 FIRE DEPARTMENT CONNECTIONS

- A. Manufacturers:
1. TYCO
 2. Elkhart Brass Mfg. Co., Inc.
 3. Croker Corp.
 4. Guardian Fire Equipment Incorporated.
 5. Potter-Roemer; Fire-Protection Div.
- B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
1. Type: Flush, with [two] [three] [four] inlets and square or rectangular escutcheon plate.
 2. Type: Exposed, projecting, with two inlets and round escutcheon plate.
 3. Finish: Polished chrome-plated.
- C. Exposed, Freestanding-Type, Fire Department Connection: UL 405, [175-psig minimum] [300-psig] pressure rating; with corrosion-resistant-metal body, brass inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, and bottom outlet with pipe threads. Include brass lugged caps, gaskets, and brass chains; brass lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-high, brass sleeve; and round, floor, brass escutcheon plate with marking "AUTO SPKR & STANDPIPE."
1. Finish Including Sleeve: Polished chrome-plated.

2.14 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch-diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.
1. Manufacturers:
 - a. TYCO
 - b. Globe Fire Sprinkler Corporation.

- c. Reliable Automatic Sprinkler Co., Inc.
 - d. Victaulic Company.
 - e. Viking Corp.
- C. Electrically Operated Alarm: UL 464, with 8-inch-minimum- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
 - 1. Manufacturers:
 - a. Potter Electric Signal Company.
 - b. System Sensor.
- D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - 1. Manufacturers:
 - a. ADT Security Services, Inc.
 - b. Grinnell Fire Protection.
 - c. ITT McDonnell & Miller.
 - d. Potter Electric Signal Company.
 - e. System Sensor.
 - f. Viking Corp.
 - g. Watts Industries, Inc.; Water Products Div.
- E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
 - 1. Manufacturers:
 - a. Grinnell Fire Protection.
 - b. Potter Electric Signal Company.
 - c. System Sensor.
 - d. Viking Corp.
- F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
 - 1. Manufacturers:
 - a. McWane, Inc.; Kennedy Valve Div.
 - b. Potter Electric Signal Company.
 - c. System Sensor.
- G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.
 - 1. Manufacturers:
 - a. Potter Electric Signal Company.

- b. System Sensor.

2.15 PRESSURE GAGES

A. Available Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch-diameter, dial pressure gage with range of 0 to 300 psig.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EXAMINATION

- A. Examine roughing-in for hose valves and fire valve cabinets to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose valve cabinets are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PIPING APPLICATIONS, GENERAL

- A. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- B. Underground Service Piping: Ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints. Include corrosion-protective encasement.

3.4 STANDPIPE SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Type or Dry-Type Standpipe System, 175-psig Maximum Working Pressure:
1. NPS 8 and smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 2. NPS 8 and smaller: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
 3. NPS 8 and smaller: Grooved-end, black or galvanized, standard-weight steel pipe with roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
 4. NPS 8: Plain-end, Schedule 10 steel pipe; steel welding fittings; and welded joints.
 5. NPS 8: Grooved-end, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. High-Pressure, Wet-Type or Dry-Type Standpipe System, 175- to 250-psig Working Pressure:
1. NPS 8 and Smaller: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 2. NPS 8 and Smaller: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
 3. NPS 8 and Smaller: Grooved-end, black or galvanized, standard-weight steel pipe with roll-grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe or Dry-pipe Sprinkler System, 175-psig Maximum Working Pressure:
1. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, NPS 2 NPS 2-1/2 NPS 3 and smaller, including mechanical-T and -cross fittings, may be used downstream from sprinkler zone valves.
 2. NPS 2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 3. NPS 2-1/2 to NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 4. NPS 2-1/2 to NPS 6: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
 5. NPS 2-1/2 to NPS 6: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. High-Pressure, Wet-Pipe and Dry-pipe Sprinkler System, 175- to 250-psig Working Pressure:
1. NPS 2: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 2. NPS 2-1/2 to NPS 6: Threaded-end, black or galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 3. NPS 2-1/2 to NPS 6: Plain-end, black, standard-weight steel pipe; steel welding fittings; and welded joints.
 4. NPS 2-1/2 to NPS 6: Grooved-end, black or galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

- A. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
 - 1. Shutoff Duty: Use ball, butterfly, or gate valves.

3.7 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 - 1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
 - 2. Steel Pipe: Roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 - 3. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.
 - 4. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.
 - 5. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.
- D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
 - 1. NPS 2 and Smaller: Use dielectric unions, couplings, or nipples.
 - 2. NPS 2-1/2 to NPS 4: Use dielectric flanges.
 - 3. NPS 5 and Larger: Use dielectric flange insulation kits.

3.8 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 22 Section "Facility Water Distribution Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 22 Section "Facility Water Distribution Piping" for backflow preventers.

3.9 WATER-SUPPLY CONNECTION

- A. Connect fire-suppression piping to building's interior water distribution piping. Refer to Division 22 Section "Domestic Water Piping" for interior piping.

- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water distribution piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

3.10 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.
- D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install drain valves on standpipes.
- K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- L. Install alarm devices in piping systems.
- M. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install standpipe system piping according to NFPA 14.
 - 2. Install sprinkler system piping according to NFPA 13.
- N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- O. Drain dry-type standpipe piping.

- P. Drain dry-pipe sprinkler piping.
- Q. Pressurize and check dry-pipe sprinkler system piping and air compressors.
- R. Fill wet-standpipe system piping with water.
- S. Fill wet-pipe sprinkler system piping with water.
- T. Install flexible connectors on fire-pump and jockey pump supply and discharge connections.
- U. Grooved-end-pipe flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. A minimum of three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration.

3.11 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- D. Specialty Valves:
 - 1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
 - 2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air supply piping.

3.12 SPRINKLER APPLICATIONS

- A. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Public areas with Suspended Ceilings: Concealed sprinklers.
 - 3. Non public areas with Suspended Ceilings: Semi-Recessed sprinklers.
 - 4. Wall Mounting: Sidewall sprinklers.
 - 5. Spaces Subject to Freezing: Upright sprinklers Pendent, dry sprinklers Sidewall, dry sprinklers.
 - 6. Special Applications: All Sprinkler heads to be Quick Response type.
 - 7. Sprinkler Finishes:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - b. Concealed Sprinklers: Rough brass, with factory-painted bright white cover plate.
 - c. Flush Sprinklers: Bright chrome, with painted bright white escutcheon.

- d. Semi-Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

3.13 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.
- D. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.
- E. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

3.14 FIRE HOSE VALVE INSTALLATION

- A. Install hose connections adjacent to standpipes, unless otherwise indicated.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.

3.15 FIRE VALVE CABINET INSTALLATION

- A. Install recessed hose stations for access and minimum passage restriction.
- B. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device, unless otherwise indicated.
- C. Install wall-mounting, recessed type fire hose valves in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Cabinets are specified in Division 10 Section "Fire Extinguisher Cabinets."

3.16 FIRE DEPARTMENT CONNECTION INSTALLATION

- ~~A. Install wall-type, fire department connections in vertical wall.~~
- B. Install freestanding-type, fire department connections in level surface.
 - 1. Install protective pipe bollards as required. Refer to Division 05 Section "Metal Fabrications" for pipe bollards.
- C. Install ball drip valve at each check valve for fire department connection.

- D. Install ball drip valve and check valve for free standing fire department connections in accessible pit.

3.17 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.
- D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- F. Connect compressed-air supply to dry-pipe sprinkler piping.
- G. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire alarm devices, including low-pressure alarm.
- H. Electrical Connections: Power wiring is specified in Division 26.
- I. Connect alarm devices to fire alarm.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- L. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.18 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.19 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Energize circuits to electrical equipment and devices.
4. Start and run air compressors.
5. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
6. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
7. Coordinate with fire alarm tests. Operate as required.
8. Coordinate with fire-pump tests. Operate as required.
9. Verify that equipment hose threads are same as local fire department equipment.

- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.20 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.21 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."
- B. Grooved coupling manufacturer's factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

END OF SECTION

SECTION 213400

JOCKEY PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Regenerative-turbine, jockey pumps.

1.2 PERFORMANCE REQUIREMENTS

- ###### **A. Pump Equipment, Accessory, and Specialty Pressure Rating:** 175 psig minimum unless higher pressure rating is indicated.

1.3 SUBMITTALS

- ###### **A. Product Data:** For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- ###### **B. Shop Drawings:** For pumps, accessories, and specialties. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- ###### **C. Field quality-control reports.**
- ###### **D. Operation and Maintenance Data:** For pumps to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- ###### **A. Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION

- ###### **A. Coordinate sizes and locations of concrete bases with actual equipment provided.**

PART 2 - PRODUCTS

2.1 REGENERATIVE-TURBINE, JOCKEY PUMPS

- A. Manufacturers:
 - 1. A-C Fire Pump Systems; a business of ITT Industries.
 - 2. PACO Pumps; Grundfos Pumps Corporation U.S.A.
 - 3. Aurora Pump.
 - 4. S.A. Armstrong Limited.
- B. Description: Factory-assembled and -tested, close-coupled, single-stage, regenerative-turbine centrifugal pump as defined in ANSI HI 1.1-1.2 and HI 1.3; with pump and motor mounted horizontally.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded inlet and outlet.
 - 2. Impeller: Bronze, balanced, and keyed to shaft.
 - 3. Pump Shaft: Stainless steel with deflector.
 - 4. Shaft Sleeve: Bronze.
 - 5. Seal: Mechanical type with spring-loaded rotating head.
- D. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."
- E. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
- F. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."
 - 1. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. NFPA Standard: Comply with NFPA 20 for installation of jockey pumps.
- B. Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."
- C. Install regenerative-turbine, jockey pumps according to ANSI HI 1.4.

- D. Provide minimum 18" clear on all sides for maintenance.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Jockey pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 ADJUSTING

- A. Lubricate pumps as recommended by manufacturer.
- B. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION

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SECTION 213900
CONTROLLERS FOR FIRE-PUMP DRIVERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Full-service, full-voltage controllers rated 600 V and less.
 - 2. Remote alarm panels.
- B. Related Sections:
 - 1. Division 21 Section "Jockey Pump" for jockey-pump controllers.

1.2 DEFINITIONS

- A. ATS: Automatic transfer switch(es).
- B. ECM: Electronic control module.
- C. MCCB: Molded-case circuit breaker.
- D. N.O.: Normally open.

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Enclosure types and details for types other than NEMA 250, Type 2.
 - c. Factory-installed devices.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of integrated unit.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
 - g. Specified modifications.

2. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
 3. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.
- C. Qualification Data: For qualified testing agency.
 - D. Product Certificates: For each type of product indicated, from manufacturer.
 - E. Manufacturer's factory test reports of fully assembled and tested equipment.
 - F. Source quality-control reports.
 - G. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of an NRTL.
- B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with standards of authorities having jurisdiction pertaining to materials and installation.
- E. Comply with NFPA 20 and NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations:
 1. Ambient Temperature Rating: Not less than 40 deg F and not exceeding 122 deg F unless otherwise indicated.
 2. Altitude Rating: Not exceeding 6600 feet unless otherwise indicated.
- B. Interruption of Existing Electric Service: Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

1.8 COORDINATION

- A. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required NEC clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 EXTRA MATERIALS

- A. ~~Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.~~
 - 1. ~~Indicating Lights: Two of each type and color of lens installed; two of each type and size of lamp installed.~~
 - 2. ~~Auxiliary Contacts: One for each size and type of magnetic contactor installed.~~
 - 3. ~~Power Contacts: Three for each size and type of magnetic contactor installed.~~
 - 4. ~~Contactor Coils: One for each size and type of magnetic controller installed.~~
 - 5. ~~Relay Boards: One for each size and type of relay board installed.~~
 - 6. ~~Operator Interface: One microprocessor board(s), complete with display and membrane keypad.~~

PART 2 - PRODUCTS

2.1 FULL-SERVICE CONTROLLERS

- A. Manufacturers:
 - 1. ASCO Power Technologies, LP; Firetrol Products.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Master Control Systems, Inc.
 - 4. Metron, Inc.
- B. General Requirements for Full-Service Controllers:
 - 1. Comply with NFPA 20 and UL 218.
 - 2. Listed by an NRTL for electric-motor driver for fire-pump service.
 - 3. Combined automatic and nonautomatic operation.
 - 4. Factory assembled, wired, and tested; continuous-duty rated.
 - 5. Service Equipment Label: NRTL labeled for use as service equipment.
- C. Method of Starting:
 - 1. Pressure-switch actuated.
 - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
 - b. System pressure recorder, electric ac driven, with spring backup.
 - c. Programmable minimum-run-time relay to prevent short cycling.
 - d. Programmable timer for weekly tests.

2. Magnetic Controller: Wye-delta (open transition) type.
 3. Solid-State Controller: Reduced-voltage type.
 4. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
- D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.
- E. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.
- F. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
 2. Method of Control and Indication:
 - a. Microprocessor-based logic controller, with multiline digital readout.
 - b. Membrane keypad.
 - c. LED alarm and status indicating lights.
 3. Local and Remote Alarm and Status Indications:
 - a. Controller power on.
 - b. Motor running condition.
 - c. Loss-of-line power.
 - d. Line-power phase reversal.
 - e. Line-power single-phase condition.
 4. Audible alarm, with silence push button.
 5. Nonautomatic START and STOP push buttons or switches.
- G. Optional Features:
1. Extra Output Contacts:
 - a. One N.O. contact(s) for motor running condition.
 - b. One set(s) of contacts for loss-of-line power.
 - c. One each, Form C contacts for high and low reservoir level.
 2. Local alarm bell.
 3. Door-mounted thermal or impact printer for alarm and status logs.
 4. Operator Interface Communications Ports: USB, Ethernet, and RS485.
- H. Automatic Transfer Switch (ATS):
1. Complies with NFPA 20, UL 218, and UL 1008.
 2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
 3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
 4. Allows manual transfer from one source to the other.
 5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
 6. Local and Remote Alarm and Status Indications:

- a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
- 7. Audible alarm, with silence push button.
 - 8. Nonautomatic (manual, nonelectric) means of transfer.
 - 9. Engine test push button.
 - 10. Start generator output contacts.
 - 11. Timer for weekly generator tests.

2.2 REMOTE ALARM PANELS

- A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.
- B. Manufacturers:
 - 1. ASCO Power Technologies, LP; Firetrol Products.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Master Control Systems, Inc.
 - 4. Metron, Inc.
- C. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.
- D. Supervisory and Normal Control Voltage: 120-V ac; single source.
- E. Audible and Visual Alarm and Status Indications:
 - 1. Driver running.
 - 2. Loss of phase.
 - 3. Phase reversal.
 - 4. Supervised power on.
 - 5. Common trouble on the controller.
 - 6. Controller connected to alternate power source.
- F. Audible alarm, with silence push button.
- G. Pump REMOTE START push button.

2.3 ENCLOSURES

- A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
 - 1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
 - 2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
- B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".
- C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

D. Optional Features:

1. Floor stands, 12 inches high, for floor-mounted controllers.

2.4 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.
 1. Verification of Performance: Rate controllers according to operation of functions and features specified.
- B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROLLER INSTALLATION

- A. Install controllers within sight of their respective drivers.
- B. Connect controllers to their dedicated pressure-sensing lines.
- C. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Comply with NEMA ICS 15.

3.3 REMOTE ALARM PANEL INSTALLATION

- A. Install panels on walls with tops not higher than 72 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

3.4 POWER WIRING INSTALLATION

- A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 CONTROL AND ALARM WIRING INSTALLATION

- A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Install wiring between remote alarm and low-suction-shutdown panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."
- C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 Section "Digital, Addressable Fire-Alarm System."
- D. Bundle, train, and support wiring in enclosures.
- E. Connect remote manual and automatic activation devices where applicable.

3.6 IDENTIFICATION

- A. Comply with requirements in NFPA 20 for marking fire-pump controllers.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 26 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Acceptance Testing Preparation:
 - 1. Inspect and Test Each Component:
 - a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
 - b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
 - c. Test continuity of each circuit.
 - 2. Verify and Test Each Electric-Driver Controller:

- a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Architect and Construction Manager before starting the motor(s).
 - b. Test each motor for proper phase rotation.
- 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
- 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Field Acceptance Tests:
 - 1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Architect, Construction Manager, Owner and authorities having jurisdiction.
 - 2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
 - 3. Engage manufacturer's factory-authorized service representative to be present during the testing.
 - 4. Perform field acceptance tests as outlined in NFPA 20.
- E. Controllers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

- A. Adjust controllers to function smoothly and as recommended by manufacturer.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
- C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- D. Set field-adjustable pressure switches.

3.10 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, low-suction-shutdown panels, and to use and reprogram microprocessor-based controls within this equipment.

END OF SECTION

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. In addition to Division 01 Specification Sections, related sections include the following:
 - 1. Division 01 Section "Cutting and Patching"
 - 2. Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
 - 3. Division 03 Sections "Cast-in-Place Concrete" and "Miscellaneous Cast-in-Place Concrete".
 - 4. Division 05 Section "Metal Fabrications" for structural steel.
 - 5. Division 09 Sections "Interior Painting" and "Exterior Painting".
 - 6. Division 08 Section "Access Doors and Frames" for access panels and doors.

1.2 RELATED REQUIREMENTS

- A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.
- B. The Contractor shall examine and coordinate with all Contract Drawings and Specifications, and all Addenda issued. Failure to comply shall not relieve them of responsibility. The omission of details of other portions of the Work from this Division shall not be used as a basis for a request for additional compensation.
- C. The specific features and details for other portions of the Work related to the construction in progress or to the building(s) shall be determined by examination at the site.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Scope of work.
 - 2. Piping materials and installation instructions common to most piping systems.
 - 3. Transition fittings.
 - 4. Dielectric fittings.
 - 5. Mechanical sleeve seals.
 - 6. Sleeves.
 - 7. Escutcheons.
 - 8. Grout.
 - 9. Plumbing demolition.
 - 10. Equipment installation requirements common to equipment sections.
 - 11. Painting and finishing.
 - 12. Concrete bases.

13. Supports and anchorages.

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. Products and Materials: Components and assemblies for the construction of the systems as indicated in the Documents including, but not limited to pipes, tubes, valves, and equipment.
- G. Products or Materials: See "Products and Materials".
- H. Provide: The materials and equipment described shall be furnished, installed and connected under this Division, complete for operation, unless specifically noted to the contrary. Identical to the phrase "furnish and install".
- I. Furnish: The material, equipment, etc. to be supplied, but not installed by the supplier.
- J. The following are industry abbreviations for materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PVC: Polyvinyl chloride plastic.
 - 4. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 5. NBR: Acrylonitrile-butadiene rubber.
- K. VFD: Variable frequency drive. This may be used interchangeably with VSD (variable speed drive), VSC (variable speed controller), and VFMC (variable frequency motor controller). This technology varies the frequency of the incoming electrical signal to change the speed of driven equipment.

1.5 SCOPE OF WORK

- A. Inspection Of Site
 - 1. The accompanying drawings do not indicate existing plumbing installations other than to identify modifications of and extensions thereof. The Contractor shall visit the site, inspect the installations and ascertain the conditions to be met and the work.

2. Failure to comply with an inspection of the site shall not constitute ground for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work under this Division.
3. Review all construction details of the new portion of the building as illustrated on the architectural and structural drawings and be guided thereby.

B. Products and Materials Description

1. Where two or more units of the same kind or class of a specific item are required, these shall be the products of a single manufacturer; however, the component parts of the item need not be the products of one manufacturer.
2. In describing the various products and materials, in general each item will be described singularly, even though there may be a multiplicity of identical items. Also, where the description is only general in nature, exact sizes, duties, space arrangements, horsepower requirements and other data shall be determined by reference to the Documents.

C. The Work shall include modifications and extensions to existing systems, and the modification of the existing structure as required accommodating the installation of the Work.

D. Refer to other Divisions of the Specifications for related Work.

E. Contractor shall install, hang, support, etc. all MEP systems and equipment to satisfy all requirements of the applicable seismic zone using performance requirements and design criteria for project site as indicated by architect.

F. It is the intent, unless otherwise indicated, that all products and materials described and specified under this Division, shall be provided for a complete working system irrespective of use of the phrases "install", "furnish", "furnish and install", or "provide" as described above has been actually included.

G. The Contractor shall be responsible for all Work of every description in connection with this Division of the Specifications.

H. The Contractor shall specifically and distinctly assume, and does so assume, all risk for damage or injury from whatever cause to property or person used or employed on or in connection with this Work and of all damages or injury to any person or property wherever located, resulting from an action or operation under the Contract in connection with the Work, and undertake the promise to defend the Owner against all claims on account of any such damage or injury.

I. The Contractor will be held responsible for the satisfactory execution and completion of the Work in accordance with the true intent of the Documents.

J. The Contractor shall provide without extra charge all incidental items required as part of the Work, even though it may not be specifically indicated. If the Contractor has reason for objecting to the use of any material, equipment, device or method of construction as indicated, he shall make report of such objections to the Owner's Representative, obtain proper approval and adjustment to the Contract, and shall proceed with the Work.

K. Electric wiring

1. All electric wiring shall be installed under Division 26, except for such equipment items as are prewired at their point of manufacture and so delivered to the project, and except for the following:

- a. Temperature Control Wiring and Power Wiring provided by controls contractor.
2. Prepare and submit for review wiring diagrams for all equipment furnished under this Division. Show on these diagrams all power, interlock, and control circuits. When the Architect takes no exception to these drawings, they shall become installation drawings for the Contractor.
3. All domestic cold and hot water piping shall be heat traced when routed external to the building or in areas susceptible to freezing conditions.

1.6 ORDINANCES, PERMITS AND CODES

- A. It shall be the Contractor's duty to perform the work and provide the materials covered by these specifications in conformance with all ordinances and regulations of all authorities having jurisdiction.
- B. All work herein shall conform to all applicable laws, ordinances, and regulations of the local utility companies.
- C. The work shall be in accordance with, but not limited to, the requirements of:
 1. National Fire Protection Association
 2. National Safety Code
 3. Wichita Falls Building Codes
 4. Texas Safety Code
 5. Texas Boiler Code
 6. Texas Department Of State Health Services
- D. Codes and standards referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes and regulations, the drawings, and specifications govern.
- E. The Contractor shall obtain permits, plan checks, connection and specification fees, inspections, and approvals applicable to the Work as required by the regulatory authorities.
- F. Fees and costs of any nature whatsoever incidental to permits, inspections, and approvals shall be assumed and paid by the Contractor.
- G. The pro-rata costs, if any, for utilities serving this property will be paid for by the Owner and shall not be included as part of this Contract.

1.7 REFERENCE STANDARDS

- A. Where differences between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents occur, the most stringent shall govern. The Contractor shall promptly notify the Owner's Representative in writing of any such difference.
- B. Should the Contractor perform any Work that does not comply with local codes, laws and ordinances, industry standards or other governing regulations, the Work shall be corrected on noncompliance deficiencies with the Contractor bearing all costs.
- C. In addition to the aforementioned ordinances, industry standards published by the following organizations shall apply:

1. AIA AMERICAN INSTITUTE OF ARCHITECTS
2. AASHTO AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
3. ACI AMERICAN CONCRETE INSTITUTE
4. AGA AMERICAN GAS ASSOCIATION
5. AISC AMERICAN INSTITUTE OF STEEL CONSTRUCTION
6. ANSI AMERICAN NATIONAL STANDARDS INSTITUTE
7. API AMERICAN PETROLEUM INSTITUTE
8. ARI AIR CONDITIONING & REFRIGERATION INSTITUTE
9. ASHRAE AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONS ENGINEERS, INC.
10. ASME AMERICAN SOCIETY OF MECHANICAL ENGINEERS
11. ASTM AMERICAN SOCIETY FOR TESTING AND MATERIALS
12. AWS AMERICAN WELDING SOCIETY CODE
13. AWWA AMERICAN WATER WORKS ASSOCIATION
14. CISPI CAST IRON SOIL PIPE INSTITUTE
15. ASPE AMERICAN SOCIETY OF PLUMBING ENGINEERS
16. FM FACTORY MUTUAL
17. IRI INDUSTRIAL RISK INSURERS
18. NBS NATIONAL BUREAU OF STANDARDS
19. NFPA NATIONAL FIRE PROTECTION ASSOCIATION
20. PDI PLUMBING AND DRAINAGE INSTITUTE
21. UL UNDERWRITER'S LABORATORIES

- D. Where the Contract Documents exceed the above requirements, the Contract Documents shall govern. In no case shall Work be installed contrary to or below the minimum legal standards.

1.8 DRAWINGS AND SPECIFICATIONS

- A. The inter-relation of the specifications, the drawings, and the schedules are as follows:
1. The specifications provide the written requirements for the quality, standard, nature of the materials, equipment and construction systems.
 2. The drawings establish the quantities, approximate dimensions, details and location of equipment.
 3. The schedules give the capacities, characteristics and components.
- B. For any individual project, if there is conflict between the drawings and or specifications, they are equivalent in authority and priority. Should they disagree in themselves, or with each other, prices shall be based on the most expensive combination of quality and quantity of work indicated. In the event of the above mentioned disagreements the resolution shall be determined by the Architect.
- C. Contractor is responsible to bring any conflicts in drawings and/or specifications to the attention of the Architect, immediately, prior to any work being done.
- D. Where the specifications do not fully agree with the schedules, the schedules shall govern. Figures given on drawings govern scale measurements and large scale details govern small scale drawings.
- E. Review all construction details illustrated on the architectural and structural drawings and be guided thereby.

1.9 SUBMITTAL PROCEDURES

- A. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.
 2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files on disc shall be in Portable Document Format (.pdf).
 3. Product Data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.
- B. Product Data: For the following:
1. Dielectric fittings.
 2. Mechanical sleeve seals.
 3. Escutcheons.
- C. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®.
 2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
 4. Shop Drawings shall be of appropriate scale based on the following:
 - a. Piping Systems, including all underfloor work: Minimum 1/8" = 1'-0".
 - b. Mechanical rooms: 1/4" = 1' – 0".
 5. Shop drawings shall include the following items:
 - a. Concrete pads and foundations.
 - b. Equipment room layouts with actual dimensions and offsets for all systems.
 - c. Roof layouts.
 - d. Trench locations and sizes.
 - e. Dimensioned floor drain locations.
- D. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project Management and Coordination". In addition to the requirements of Division 01 comply with the following:

1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.
2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.
3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.

E. Coordination Drawings: Prepare drawings showing dimensioned layout for the following:

1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.
2. Shop drawings shall be provided for the following:
 - 1) Sheet Metal and Duct Systems, including all underfloor work (prepared at a minimum scale of 1/8"=1'-0")
 - 2) Piping and equipment systems for storm, domestic water, waste and vent and other plumbing piping systems. (Preferably at 1/4" = 1' – 0" and not less than 1/8" = 1' – 0").
 - 3) Equipment room layouts with actual equipment, piping, and duct at 1/4" = 1' – 0" scale. Show clearances, access spaces, relative heights of piping.
 - 4) Housekeeping and equipment concrete pads.
 - 5) Dimensioned floor drain locations and the equipment each serves.
 - 6) Roof layouts.
 - 7) Trench locations and sizes.
- b. Equipment support locations, type of support, and weight on each support.
- c. Location of structural supports for structure-supported raceways.
- d. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.
- e. **Location of structural supports for seismic bracing.**

F. Common Requirements for Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" for "Other Informational Submittals". In addition to the requirements of Division 01 comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with "Compliance". Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
 - a. "C" for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.

- b. "D" for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
- c. "A" for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
- d. "N/A" for Not Applicable: By noting the term "not applicable" or "N/A" in the margin, it shall be understood that the specified item is not applicable to the project.

G. Common Requirements For Qualification Data:

- 1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of registration in the Project location.
- 2. Independent Testing and Inspecting Agency Certification: Where this Section and other Sections of this Division require an Independent Testing and Inspecting agency to be responsible for Acceptance Testing and Field Quality Control requirements; Submit certification documentation for such agency that demonstrates compliance with the Quality Assurance paragraph of this Section.

H. Qualification Data: For Independent Testing and Inspecting Agency.

I. Welding certificates.

1.10 SUBSTITUTIONS

- A. Where the product of a single manufacturer is mentioned by trade name or manufacturer's name in this Division, it is the only acceptable manufacturer.
- B. Where two or more manufacturers are named, only those manufacturers will be considered or approved.
- C. Manufacturers not listed will be considered for substitution prior to bid only. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum ten (10) business days prior to bid with each sub-paragraph noted with the comment, "compliance", "deviation", "alternate" or "not applicable". In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.
 - 1. By noting the term "compliance" or "C", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - 2. By noting the term "deviation" or "D", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
 - 3. By noting the term "alternate" or "A", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.
 - 4. By noting the term "not applicable" or "N/A", it shall be understood that the specified item is not applicable to the project.

- D. It shall be understood that space allocations have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer whether indicated or not.
- E. Any product or material offered in substitution which differs in dimension or configuration from the Documents, the Contractor shall provide as part of the submittal a drawing, minimum 1/4" = 1'-0" scale, showing that the substitution can be installed in the space available without interfering with other portions of the work or with access for operations and maintenance in the completed project.
- F. Where substitute products or materials requiring different arrangement or connections from that indicated is accepted by the Owner's Representative, install the equipment or devices to operate properly and in harmony with the intent of the Documents, making all incidental changes in piping or wiring resulting from the substitution without any additional cost to the Owner.
- G. The Contractor shall pay all additional costs incurred by other portions of the work in connection with all substitutions.
- H. The Owner's Representative reserves the right to call for samples of any item of product or material offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.
- I. When any request for a substitution of a product or material is submitted and rejected, the item named in the Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.

1.11 QUALITY ASSURANCE

- A. All Work shall be performed by properly licensed technicians skilled in their respective trades. All materials, equipment and devices shall be installed in accordance with the recommendations of the manufacturer and in the best standard practice to bring about results of a first class condition.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. Electrical Characteristics for Plumbing Equipment:
 - 1. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
 - 2. Where variable frequency drives are provided for equipment, whether installed separately or integral to the equipment, the VFDs shall conform to Division 26 section, "Variable Frequency Motor Controllers".

- E. Wherever a UL standard has been established for a particular type of material, equipment or device, each item of such material, equipment or device provided on this project shall meet the requirements of the UL standard in every way, and shall be UL listed and labeled.
- F. Products and materials shall be of the best quality customarily applied in quality commercial practice, and shall be by reputable manufacturers.
- G. Each major component shall bear a nameplate giving the name and address of the manufacturer, and the catalog number or designation of the component.
- H. Products and materials provided under this Division of the Specifications shall be essentially the standard item, unless otherwise noted, of the specified manufacturer, or where allowed, an alternate manufacturer.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products and materials with factory-applied end caps or "heat shrink" wrappings to protect openings. Maintain opening protection through shipping, storage, and handling to prevent damage and the entrance of dirt, debris, and moisture.
- B. Store light sensitive products and materials away from and protected against direct sunlight.
- C. Support products and materials at all times to prevent sagging and bending.
- D. The area provided for product and material storage at the jobsite shall be clean, dry and exposure to dust minimized.
- E. Responsibility for the protection of products and materials shall extend to existing equipment, systems, and products and materials. Erect temporary sheltering structures, provide temporary bracing and supports, or cover existing equipment, systems, and products and materials to prevent damage and the entrance of dirt, debris, and moisture.
- F. Failure on the part of the Contractor to comply with the above to the satisfaction of the Architect, Engineer, or either's authorized representative shall be sufficient cause for the rejection of products and materials in question.

1.13 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.
- D. Installation Drawings
 - 1. Prepare special drawings as called for elsewhere herein or directed by the Architect to coordinate this work with the work of other Divisions, to illustrate changes in this work to facilitate its concealment in finished spaces, to avoid obstructions, or to illustrate the installation of a substitute equipment item.

2. Use these drawings in the field for the installation of the work. Unless otherwise directed, do not submit these drawings for review, but provide 3 copies to the Architect for information.

E. Schedule And Sequence Of Work

1. The Contractor shall meet and cooperate with the Owner and Owner's Representative to schedule and sequence Work so as to ensure meeting scheduled completion dates and avoid delaying other portions of the Work. Work requiring special sequencing shall be at no additional cost to the Owner and shall have no impact on the schedule.
2. Work schedules and completion dates as established shall be rigidly adhered to. Cooperate in establishing these schedules and perform the work under this Division at such times as directed so as to ensure meeting scheduled dates and avoid delaying any other Contractor.
3. Any work involving a service suspension shall be scheduled in advance with the Owner.
4. Should it be necessary to perform certain operations on an "overtime" basis in order not to interrupt the normal usage of the facility, include the costs of such overtime without change in the Contract amount.
5. The Contractor shall be responsible for coordinating the demolition and tie-in of the central plant system with the Owner and construction manager.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. All piping and tubing shall be American manufactured, unless otherwise indicated.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Innerlinx by Mason Dallas.
 - b. Metraflex Co.
 - c. Linkseal by Thunderline.
 - 2. Sealing Elements: EPDM for high temperature applications and NBR for all others unless otherwise indicated, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10, galvanized, plain ends.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.
- C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.

- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- E. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 SALVAGED MATERIALS

- A. Reuse no salvaged material except as noted on the Drawings, specified herein, or directed by the Architect. Remove from the premises all present materials falling under this Division, which are removed from the existing building. Upon completion, leave no "dead" line or equipment installed in any portion of the area being remodeled.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction

loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons, after Architect's final approval of finish, for penetrations of walls, ceilings, and floors according to the following:
 - 1. New piping penetrations shall be one-piece escutcheons.
 - 2. Existing piping penetrations shall be two-piece escutcheons.
 - 3. All sleeved penetrations shall be deep-drawn to allow flush installation between escutcheon and finished surface.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level to prevent water entrance to the sleeved hole. Vertical pipe supports must be extended to and supported by the floor and not the sleeve.
 - b. Strike above subparagraph and retain subparagraph below when a pipe curb is required at all floor penetrations in lieu of extended sleeves.
 - c. Provide concrete pipe curb in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

- c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - N. Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter for above ground locations.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter for above ground and all underground locations.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
 - Q. Verify final equipment locations for roughing-in.
 - R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.4 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- K. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Equipment called for on the plans and not listed herein shall be provided as though it were fully described herein.
- B. Equipment called for herein shall be completely provided, whether fully detailed or not on the plans, and/or scheduled.
- C. All equipment as indicated on the plans and as described herein shall be installed per manufacturer's recommendations to allow for proper operation and maintenance of the equipment.
- D. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- F. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- G. Where any piece of equipment is too large for ingress through normal building openings, it shall be placed in its containing space before the enclosing structure is completed.
- H. Install equipment to allow right of way for piping installed at required slope.

3.7 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases not less than 4 inches larger in both directions than supported unit.
 - 2. Concrete bases for all equipment shall be 4 inches (100 mm) tall above finished floor.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.11 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.12 INSTALLATION, INSPECTIONS AND CERTIFICATIONS

- A. The Contractor shall obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspecting authority.
- B. Upon final completion of the work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Architect for transmission to the Owner.

3.13 OPERATION PRIOR TO COMPLETION

- A. When any piece of mechanical or electrical equipment is operable and it is to the advantage of the contractor to operate the equipment, he may do so with permission of Owner, providing that he properly supervises the operation, retains full responsibility for the equipment operated, and protects against dirt accumulations during operation. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner or until final acceptance by the Owner.
- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, and properly adjust the operation of the equipment before final acceptance by the Owner.

3.14 INSTRUCTION OF OWNER'S PERSONNEL

- A. Provide the services of competent engineers and/or technicians acceptable to the Owner's Representative to instruct other representatives of the Owner in the complete and detailed operation of each item of equipment or device of all the various electrical systems. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results.
- B. Upon completion of these instructions, the Contractor shall obtain a letter of release, acknowledged by the Owner or his authorized representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.
- C. The Contractor shall be fully responsible for proper maintenance of equipment and systems until the instructions have been given the Owner's personnel and the letter of release acknowledged.
- D. In providing the instructions to the Owner's personnel, the written operating and maintenance manuals shall be followed in all instances, and the Owner's personnel shall be familiarized with such manuals.
- E. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturer's operating and maintenance instructions, parts lists (with sources identified), and other data as appropriate for each system.

3.15 SEALANT

- A. Apply sealant to penetrations of all floor and wall assemblies to maintain pressure differentials required by AIA for all pressure sensitive rooms. Sealant materials and installation requirements are specified in Division 07 Section "Joint Sealants" and Division 09 Section "Gypsum Board Assemblies."

END OF SECTION

SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.

B. Related Sections:

1. Division 22 Section "Facility Water Distribution Piping" for domestic and fire-protection water service meters outside the building.
2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.
3. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.2 DEFINITIONS

- A. CR:** Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM:** Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

- A. Product Data:** For each type of product indicated; include performance curves.
- B. Shop Drawings:** Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates:** For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 THERMOMETERS

- A. Digital Vari-angle Thermometer, self-powered and within 1% accuracy, Similar to Weiss Model DVU35.**
1. Case: Hi-impact ABS
 2. Range: -40/300 °F (-40/150 °C)
 3. Display: 3/8" LCD digits, wide ambient formula
 4. Accuracy: 1% of reading or 1° whichever is greater

5. Resolution: 1/10° between -19.9/199.9 °F (-28/93 °C)
6. Recalibration: Internal potentiometer
7. Lux Rating: 10 Lux (one foot-candle)
8. Update Rate: 10 seconds
9. Ambient Operating Range: -30/140 °F (-35/60 °C)
10. Ambient Temp. Error: Zero
11. Humidity: 100%
12. Sensor: Glass passivated thermistor
13. Connector: adjustable angle

2.2 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type 304 stainless steel fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ernst Gage Co.
 2. Miljoco Corp.
 3. Trerice, H. O. Co.
 4. Weiss Instruments, Inc.
 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
 6. Dwyer Instruments, Inc.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 1. Case: Liquid-filled type, cast aluminum, 4 1/2-inch (114-mm) diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 6. Pointer: Red or Black metal.
 7. Window: Glass.
 8. Ring: Stainless steel.
 9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 50 psig of pressure.
 11. Range for Fluids under Pressure: Two times operating pressure.
- C. Pressure-Gage Fittings:
 1. Valves: NPS 1/4 brass or stainless-steel ball type.
 2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.
 3. Syphons: NPS 1/4 (DN 8) coil of brass tubing with threaded ends.

2.4 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. MG Piping Products Co.
 - 3. National Meter, Inc.
 - 4. Peterson Equipment Co., Inc.
 - 5. Sisco Manufacturing Co.
 - 6. Trerice, H. O. Co.
 - 7. Watts Industries, Inc.; Water Products Div.
- B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- D. Core Inserts: One or two self-sealing rubber valves.
 - 1. Insert material for water service at 20 to 200 deg F shall be CR.
 - 2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install digital thermometers in the following locations:
 - 1. Inlet and outlet of each domestic water heater.
 - 2. Inlet and outlet of each thermostatic mixing valve.
- B. Install thermometers in separable sockets at each additional location indicated on the Drawings or specified elsewhere herein.
- C. Provide the following temperature ranges for thermometers:
 - 1. Domestic Hot Water: 30 to 200 deg F, with 2-degree scale divisions.
 - 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE COCK APPLICATIONS

- A. Install test plugs adjacent to all control sensors (except Insertion Type Flow Meters) installed in piping systems.
- B. Valved pressure gage connections shall be installed in each location indicated on the Drawings and/or specified elsewhere herein.
- C. Install each gage cock on a nipple of sufficient length so that the cock handle will be free of the pipe insulation. Position each cock so that a 4 1/2" diameter dial gage may be easily read and screwed into and out of the cock.

- D. On pumps use a single pressure gage connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable.
- E. Install gage cocks at each pump as close to pump suction and discharge connections as practicable. Use any gage connections provided in the pump casing.

3.3 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.
- B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.
- C. Furnish and install calibrated pressure gauges at each location indicated on the Drawings, specified elsewhere herein, and/or as a standard.

3.4 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install ball-valve and snubber or syphon fitting in piping for each pressure gage.
- E. Install test plugs in tees in piping.
- F. Install connection fittings for attachment to portable indicators in accessible locations.
- G. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- H. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION

SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Ferrous-alloy ball valves.
3. Ductile-iron butterfly valves.
4. Bronze check valves.
5. Cast-iron swing check valves.
6. Spring-loaded, lift-disc check valves.

B. Related Sections include the following:

1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and charts.
3. Division 22 piping Sections for specialty valves applicable to those Sections only.
4. Division 23 "Facility Natural Gas Piping" for natural gas valves.

1.2 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. TFE: Tetrafluoroethylene plastic.
6. NRS: Nonrising stem.
7. OS&Y: Outside screw and yoke.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; furnished specialties; and accessories.

1.4 QUALITY ASSURANCE

A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

- B. NSF Compliance: NSF 61-G for valve materials for potable-water service.
- C. Bronze valves shall be made with dezincification-resistant materials. All valves shall comply with the current edition of recognized industry standards for design, materials and testing. These standards include but are not limited to MSS SP-80 and MSS SP-110.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged or grooved ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Gear Drive: For quarter-turn valves NPS 8 and larger.
 - 3. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- G. Extended Valve Stems: On insulated valves. Valves shall have 2-inch (50-mm) stem extensions and the following features:

1. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.

- 1) NIBCO Nib-seal handle extension
- 2) Conbraco Industries, Inc.; Apollo Div.
- 3) Jamesbury, Inc.
- 4) Kitz Insulated Stem Extension Model #ISE 1 thru 4
- 5) Milwaukee Valve: The Insulator/MS

2. Butterfly Valves: Shall have extended necks.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

J. Solder Joint: With sockets according to ASME B16.18.

1. Caution: Use solder with melting point below 840 deg F for check valves; below 421 deg F for ball valves.

K. Threaded: With threads according to ASME B1.20.1.

L. Valve Bypass and Drain Connections: MSS SP-45.

2.2 COPPER-ALLOY BALL VALVES

A. Brass Ball Valves, General: MSS SP-110 and have a brass body complying with ASTM B 283.

B. Bronze Ball Valves, General: MSS SP-110 and have a copper alloy body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded, solder or press connection ends, and blowout-proof stems.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: Chrome-plated bronze ball and bronze stem and; reinforced TFE seats; threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, solder, threaded or press connection ends; and 150 psig SWP 600-psigCWP rating.

1. NIBCO Model S-585-80-LF or T-585-80-LF
2. Conbraco Industries, Inc.; Apollo Div.
3. Crane Co.
4. Watts Model

5. Kitz Model 868 or 869
6. Milwaukee UPBA450 or UPBA400
7. Hammond UP8311A or UP88301A

D. Two-Piece, Full-Port, Copper-alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, soldered or threaded or press connection ends; 150 psig SWP and 600-psig CWP ratings.

1. NIBCO Model S-585-66-LF or T-585-66-LF
 2. Conbraco Industries, Inc.; Apollo Div.
 3. Crane Co. Model
 4. Watts Model

 5. Kitz Model 868M or 896M
 6. Milwaukee UPBA400S, UPBA450S
 7. Hammond UP8303A, UP8313A
- E. Three-Piece, Full Port, Copper-alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, stainless nuts and bolts on valve body, soldered or threaded or press connection ends; 150 psig SWP and 600-psig CWP rating.
1. NIBCO Model S-595-Y-66-LF or T-595-Y-66-LF
 2. Conbraco Industries, Inc.; Apollo Div.
 3. Crane Co.

 4. Kitz Model 862M or 863M
 5. Milwaukee UPBA350S, UPBA300S
 6. Hammond UP8613, UP8603

2.3 BRONZE BUTTERFLY VALVES

- A. Bronze Butterfly Valves, General: CTS 2 (DN50) – 8 (DN300), 300-psig CWP rating with offset, aluminum-bronze disc and bronze cast body. Bubble tight bi-directional and dead-end service at full rated pressure.
1. Victaulic Company Style 608N

2.4 DUCTILE or CAST IRON BUTTERFLY VALVES

- A. Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:
1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.
 2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator.
- B. Class 150: 175-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 400 series stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.
1. NIBCO Model LD-1000
 2. Cooper Cameron Corp. Model NF-C (238 Series) 511435-A
 3. DeZURIK; SPX Corporation Model BRS Series BHP, (Size),LD-DI-EPDM-EPDM-BZ-S4-*

 4. Kitz Model #6123E
 5. Crane

6. Milwaukee ML333E
7. Hammond 6411
8. Grinnell

- C. Class 200: 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one-piece Type 400 series stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem, to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. NIBCO Model LD-2000
2. Cooper Cameron Corp. Model NF-C (221Series) 511435-*
3. DeZURIK; SPX Corporation Model BRS (Size) LD-DI-EPDM-EPDM-BZ-S4-*
4. Kitz Model #6123E
5. Crane
6. Milwaukee ML333E
7. Hammond 6411
8. Grinnell

- D. Grooved-End, Ferrous-Alloy Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc or electroless nickel coated ductile iron disc with EPDM seal, Ductile-iron body or stainless steel body with grooved ends, polyamide coating inside and outside or alkyd enamel inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing or TFE lined fiberglass and brass bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. NIBCO Model GD-4765
2. Victaulic Co. of America. Model Vic-300-Master Seal Style 361 or Style 461.

2.5 BRONZE CHECK VALVES

- A. Bronze Check Valves, General: MSS SP-80.
- B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model 836 or 826
3. NIBCO Model S-480-Y-LF or T-480-Y-LF
4. Powell, Wm. Co.
5. Milwaukee UP1548T, UP548T
6. Hammond UP947, UP943

- C. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model 822T or 823T
3. NIBCO Model S-413-Y-LF or T-413-Y-LF
4. Powell, Wm. Co.
5. Milwaukee UP1509, UP509
6. Hammond UP912, UP904

- D. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz #30T or #29T
3. NIBCO Model S-433-Y or T-433-Y
4. Powell, Wm. Co.
5. Milwaukee 1510T, 510T
6. Hammond IB945

2.6 IRON SWING CHECK VALVES

- A. Iron Swing Check Valves, General: MSS SP-71.
- B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model 78
3. NIBCO Model F-918-N
4. Powell, Wm. Co.
5. Milwaukee F-2974-M
6. Hammond IR1126-HI

- C. Grooved-End, Spring Assisted Check Valves: ASTM A536 Ductile-iron body with grooved ends, stainless steel spring and synthetic seats and having 250-psig CWP Rating.

1. Anvil International, Inc.
2. NIBCO Model G-917-W
3. Victaulic Co. of America

2.7 IRON SPRING-LOADED, LIFT-DISC CHECK VALVES

- A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.
- B. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.

1. NIBCO Model F-910-B-LF
2. Metraflex Co.
3. Kitz Model 7022
4. Milwaukee 1800
5. Hammond IR9354

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Throttling Service: Ball or butterfly valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- C. Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
 - 2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full port, ferrous alloy.
 - 3. Butterfly Valves, NPS 2 to NPS 12 (DN 50 to DN 300): Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ductile iron.
 - 4. Butterfly Valves, NPS 14 (DN 350) and Larger: Single-flange, full lug, 150-psig CWP rating, bronze disc, EPDM liner, ductile iron.
 - 5. High-Pressure Butterfly Valves, NPS 2-1/2 (DN 65) and Smaller: Single-flange full lug, 285 psig (1964 kPa) CWP rating.
 - 6. Grooved-End, Bronze Butterfly Valves, CTS 2 to 8 (DN 50 to DN 300): 300-psig (2070-kPa) CWP rating, EPDM-encapsulated aluminum-bronze or stainless steel disc.
 - 7. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2 to NPS 8: 300-psig CWP rating, EPDM- encapsulated ductile-iron disc.
 - 8. Grooved-End, Ductile-Iron Butterfly Valves, NPS 10 to NPS 12 250 to DN 300): 200-psig CWP rating, EPDM- encapsulated ductile-iron disc.
 - 9. Lift Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.

10. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze with TFE disc.
11. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, cast-iron, standard.
12. Grooved-End Swing Check Valves, NPS 2-1/2 and Larger: Grooved-end, ductile-iron, swing check valves.
13. Spring-Loaded, Center-Guided, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, flanged end, iron.

D. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded or press connection ends.
2. For Copper Tubing, NPS 2-1/2: Flanged ends.
3. For Grooved-End, Copper Tubing: Valve ends may be grooved.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.
 2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

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SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Pipe stands.
 - 6. Pipe positioning systems.
 - 7. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
 - 3. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Pipe hangers and supports shall conform to the recommendations of ASHRAE, ASPE, ANSI, and MSS, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For the following:

Midwestern State University
Health Science & Human Services Center
RSA Project No. 1612.00

220529 - 1

HANGERS AND SUPPORTS FOR
PLUMBING PIPING AND
EQUIPMENT
100% Construction Documents
September 1, 2017

1. Steel pipe hangers and supports.
 2. Fiberglass pipe hangers.
 3. Thermal-hanger shield inserts.
 5. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Fiberglass strut systems. Include Product Data for components.
 4. Pipe stands. Include Product Data for components.
 5. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
 2. AWS D1.2, "Structural Welding Code--Aluminum."
 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
1. AAA Technology & Specialties Co., Inc.
 2. Bergen-Power Pipe Supports.
 3. B-Line Systems, Inc.; a division of Cooper Industries.
 4. Carpenter & Paterson, Inc.
 5. Empire Industries, Inc.
 6. ERICO/Michigan Hanger Co.
 7. Globe Pipe Hanger Products, Inc.
 8. Grinnell Corp.
 9. GS Metals Corp.
 10. National Pipe Hanger Corporation.
 11. PHD Manufacturing, Inc.
 12. PHS Industries, Inc.
 13. Piping Technology & Products, Inc.
 14. Tolco Inc.

15. Anvil International

- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
 - 8. Anvil International
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 CUSHION CLAMPS FOR MEDICAL GAS

- A. Clamps for trapeeze style hangers, designed to isolate copper medical gas piping from dissimilar metals.
- B. Manufacturers:
 - 1. Tolco Inc.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.

2.5 FASTENER SYSTEMS

- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Available Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Empire Industries, Inc.
- c. Hilti, Inc.
- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.

2.6 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. ERICO/Caddy Pyramid
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. MIRO Industries.
 - b. Portable Pipe Hangers.
 - c. ERICO/Caddy Pyramid
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. ERICO/Caddy Pyramid
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 - 2. Base: Plastic or Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. Portable Pipe Hangers.
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.
 1. Available Manufacturers:
 - a. Pate.
 - b. Thy Curb.
 - 1) Models:
 - a) TC-1 for insulated roof decks.
 - b) TC-2 for un-insulated and existing roof decks.
 - c) TC-3 for Bulb-T roof decks.
 2. Pipe curbs and rails with covers shall be all welded 18 gauge galvanized steel shell and baseplate, wood nailer, and TP-1 Duro EPDM cover or TP-2 pipe cover, as detailed on the drawings, for pipe penetration(s).

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
 1. C & S Mfg. Corp.
 2. HOLDRITE Corp.; Hubbard Enterprises.
 3. Samco Stamping, Inc.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.
 1. Available Manufacturers:
 - a. Pate.
 - b. Thy Curb.
 - 1) Models:
 - a) TEMS-1 for insulated roof decks.
 - b) TEMS-2 for un-insulated and existing roof decks.
 - c) TEMS-3 for single-ply roof systems.
 2. Equipment supports shall be all welded 18 gauge galvanized steel shell, baseplate and counterflashing with internal bulkhead re-enforcement and wood nailer.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to proper placement of inserts, anchors and other building structural attachments.

3.2 HANGER AND SUPPORT APPLICATIONS

- A. Use only one type hangers and supports, by one manufacturer, for each piping service.
- B. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- C. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- D. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing or provide copper-plated hangers and supports for copper piping systems where hangers are in contact with bare pipe.
- G. Use padded hangers for piping that is subject to scratching.
- H. Horizontal-Piping Hangers and Supports, Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping. Unless otherwise indicated and except as specified in piping system Sections, install the following types. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- I. Vertical-Piping Clamps: Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Select size of hanger rod attachments to suit hanger rods. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Select spring hangers and supports to suit pipe size and loading. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- N. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.3 MEDICAL GAS HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Use cushion clamps on all medical gas piping
- C. Vertical Piping: MSS Type 8 or 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches of each fitting and coupling.

- H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1/4: 60 inches with 3/8-inch rod.
 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 3. NPS 3/4: 84 inches with 3/8-inch rod.
 4. NPS 1: 96 inches with 3/8-inch rod.
 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 7. NPS 2: 11 feet with 3/8-inch rod.
 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 9. NPS 3: 14 feet with 1/2-inch rod.
 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 11. NPS 4: 16 feet with 1/2-inch rod.
 12. NPS 5: 18 feet with 1/2-inch rod.
 13. NPS 6: 20 feet with 5/8-inch rod.
 14. NPS 8: 23 feet with 3/4-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required by the following table to properly support piping from building structure.

Pipe Size (in)	Max. Hanger Spacing (ft)	Min. Rod Size (in)	Max. Alternate Hanger Spacing (ft)	Min. Alternate Rod Size (in)
1/2	6	3/8	--	--
3/4	6	3/8	--	--
1	7	3/8	--	--
1-1/4	8	3/8	--	--
1-1/2	9	3/8	--	--
2	10	3/8	--	--
2-1/2	11	1/2	--	--
3	12	1/2	8	3/8
3-1/2	13	5/8	8	3/8
4	14	5/8	8	3/8
5	16	5/8	10	1/2
6	17	3/4	10	1/2
8	19	7/8	10	1/2
10	20	7/8	10	1/2
12	20	7/8	10	1/2
14	20	1	16	7/8
16	20	1-1/8	14	7/8
18	20	1-1/4	10	7/8
20	20	1-1/4	10	7/8
24	20	1-1/4	8	7/8

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1 inch

3.8 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, laminated phenolic with a black surface and white substrate for mechanical engraving, 1/16 inch Minimum thick, and having predrilled holes for attachment hardware and beveled edges.

2. Letter Color: White
 3. Background Color: Black
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, as directed by the owner. Secondary lettering shall indicate date of installation.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- D. Punched plastic tape for labels is not acceptable.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1 inch for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Labels shall conform to ANSI A13.1 and the following table:

Outside Diameter of Pipe of Covering	Height of Letters
3/4" to 1-1/4"	1/2"

1-1/2" to 2"	3/4"
2-1/2" to 6"	1-1/4"
8" to 10"	2-1/2"
Over 10"	3-1/2"

- B. Available Manufacturers: Seton, Brady, or Westline.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link and S-hook or beaded chain
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Reinforced grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "High-Performance Coatings."
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. In no case shall an exposed line enter or leave a room without being identified.
 - 8. Secure identification markers to piping by firmly pressing markers in place, following removal of protective covering. Additionally secure by banding ends of markers in place using 1/2 inch wide aluminum bands of the type normally used to secure insulation in place.
- C. Pipe Label Color Schedule: COORDINATE WITH OWNER
 - 1. Low-Pressure, Compressed-Air Piping:
 - a. Background Color: Black.
 - b. Letter Color: White.
 - 2. Medium-Pressure, Compressed-Air Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.
 - 3. Domestic Water Piping:

- a. Background Color: Blue.
- b. Letter Color: Black.

4. Sanitary Waste and Storm Drainage Piping:

- a. Background Color: White.
- b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

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SECTION 220700

PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
2. Factory-applied jackets.
3. Field-applied cloths.
4. Field-applied jackets.
5. Adhesives.
6. Mastics.
7. Sealants.
8. Tapes.
9. Securements.
10. Thermal Hanger-Shield Inserts

1.2 SUBMITTALS

- A. Product Data:** For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Calculations:** For insulation submitted outside of the conductivity range per the "Minimum Pipe Insulation Thickness" Table for the application listed, submit thickness calculations.
- C. Shop Drawings:**
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail attachment and covering of heat tracing inside insulation.
 3. Detail insulation application at pipe expansion joints for each type of insulation.
 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 6. Detail application of field-applied jackets.
 7. Detail application at linkages of control devices.
 8. Detail field application for each equipment type.
- D. Samples:** For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Sample Sizes:

- a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
- b. Sheet Form Insulation Materials: 12 inches square.
- c. Jacket Materials for Pipe: 12 inches long by NPS 2.
- d. Sheet Jacket Materials: 12 inches square.
- e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

E. Qualification Data: For qualified Installer.

F. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

G. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

- 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 Manufacturers:

- A. Owens-Corning
- B. Johns-Manville
- C. Pittsburg-Corning
- D. Manson (Certain Teed)
- E. Knauf Fiberglass
- F. Aerocel EPDM
- G. Armacell

2.2 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Block Insulation: ASTM C 552, Type I.
 2. Special-Shaped Insulation: ASTM C 552, Type III.
 3. Preformed Pipe Insulation with Factory-Applied ASJ - SSL: Comply with ASTM C 552, Type II, Class 2.
 4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.3 ADHESIVES

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide insulation adhesive and jacket manufacturer shall provide jacket adhesive.
- B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- C. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
- D. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- F. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide mastics.
- B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 4. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 200 deg F.
 3. Solids Content: 63 percent by volume and 73 percent by weight.
- E. Color: White.

2.5 SEALANTS

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide sealants
- B. Joint Sealants for Cellular-Glass Products:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
- D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: White.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 - 5. PVDC Jackets
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - b. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - c. for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a

flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

- d. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Avery Dennison Corporation, Specialty Tapes Division.
 - 2. Compac Corp.
 - 3. Ideal Tape Co., Inc., an American Biltrite Company.
 - 4. Venture Tape.
 - 5. Dow Chemical Company (The).
- B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 - 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.

2.11 PIPE INSULATION HANGER SHIELDS:

- A. Provide shields for hangers on all insulated pipe.
- B. Insulation and shields shall consist of a 180 degree galvanized sheet steel shield. Shield lengths and minimum sheet metal gauges shall be as directed below:

<u>PIPE SIZE</u>	<u>SHIELD LENGTH</u>	<u>MINIMUM GAUGE</u>
1/2" to 8"	12"	16
10" & Larger	22"	16

- C. Shields shall be Model CS-CW, except for pipe roller applications and where pipe hanger spacing exceeds 10 feet, then provide Model CSX-CW.
- D. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.

2.12 PREMANUFACTURED COVERS

- A. Preformed manufactured PVC fitting covers with rigid one piece (half-shell) preformed rigid insulation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Materials shall be applied by a qualified insulation applicator/workman skilled in this trade. Insulation shall be installed in accordance with the manufacturers written instructions and in accordance with recognized industry standards. Mechanical fasteners shall be used whenever possible to assure permanent construction. Unsightly work shall be cause for rejection.
- B. Materials shall be applied only after surfaces have been tested and thoroughly cleaned of all mill scale, grease and dirt.
- C. Non-compressible insulation material shall be installed at hanger supports on cold piping to prevent damage to insulation and vapor barrier. All wet pipe insulation shall be replaced.
- D. Insulation of cold surfaces shall be vapor-sealed to prevent condensation.
- E. Minimum thickness of insulation shall be as scheduled.
- F. Install Pipe Insulation Hanger Shields.
- G. Where piping system insulation is specified, cover valves, strainers, unions, flanges, and fittings. Refer to Preformed fitting and valve covers.
- H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, there shall be no exceptions.

3.2 APPLICATION TYPES

- A. Equipment

- E1: Cut insulation to fit contour of equipment, and secure by means of bands or adhesives as required for each individual piece of equipment. Provide vapor barrier and finish as required for each specific application. Provide new cold surfaces of pumps with accessible boxes that easily separate coincidental with parting line of evaporator heads and pump casings. Resulting insulation joints shall be covered with a self-sealing, vapor-barrier tape. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

B. Piping

- P1: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Use of double tape self-sealing adhesives systems will negate requirements for staples.
- P2: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.
- P3: Same as P2, except install insulation over heat trace tape. Finish with metal jacket.

3.3 INSULATION SCHEDULE KEYS

Insulation Types Key					
	Type	Maximum K Factor @ 75°F	Temp. Limit °F	Density Lb. Per Cubic Foot	Federal Spec. Compliance
1.	Calcium Silicate	0.38	1200	14	HH-I-523C
2.	Fiberglass (Rigid)	0.23	450	3	ASTM C 547 Type 1
3.	Foamed Glass (Cellular)	0.36	850	9	HH-I-1751/3A
4.	Foamed Plastic (Flexible)	0.25	220	5	HH-I-573
5.	Insulating Cement	0.7	1700		SS-C-160

Finishes Key	
F1.	8-ounce glass cloth
F2.	Insulation cement
F3.	0.016 aluminum, plain, up through 12" pipe size; 0.016 aluminum, corrugated, for pipe sizes 14" and larger
F4.	White all-service jacket (vapor barrier) with self-sealing lap, or taped joints
F5.	Two coats vinyl lacquer type white paint

3.4 EQUIPMENT AND PIPING INSULATION SCHEDULES

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following unless there is a potential for personnel injury.
1. Drainage piping located in crawl spaces.
 2. Underground piping.

3. Chrome-plated pipes and fittings.

C. Fitting and Valve Covers:

1. Fitting covers shall be of preformed PVC for indoor service and metal for outdoor service.
2. Insulation material shall be rigid and of the same or greater material type and thickness, density and conductivity as the adjoining pipe. Blanket inserts will not be allowed.
3. Field fabricated fitting covers of same or similar material as pipe covering with preformed rigid inserts as specified in paragraph 1 above

- D. Exposed piping for ADA compliant lavatories shall be provided with premanufactured covers complying with ASTM E-84 for P-traps, waste piping and angle stop valves.

EQUIPMENT AND PIPING INSULATION SCHEDULE						
	INSULATION TYPE	THICKNESS	APPLICATION TYPE	INSULATION FINISH		
				INDOOR CONCEALED	INDOOR EXPOSED	OUTDOOR
Domestic cold water; bottom of roof drains and overflow drains; horizontal storm drains and overflow drains within building; waste piping conveying cooling coil condensate; waste from chilled drinking water fountains.						
Indoor:	2	1"	P2	F4	F4	--
Outdoor:	2	1"	P2/P3		--	F4 & F3
Domestic hot water supply & recirculation.						
Indoor:	2	Note 1	P1	F4	F4	--
Domestic water pumps.						
Indoor:	2 3 4	2"	E1	--	F1 F2 F3 F5	F3 F5
Domestic water storage tank						
Indoor:	2	1 1/2"	E1	--	F2 & F1	F4 & F3
Medical Vacuum pump exhaust piping						
Indoor:	1	2"	P1	--	F2	--

* Provide insulation where piping is heat traced.

** Refer to insulation types and finishes keys.

*** Table does not apply to factory insulated equipment

Note 1 – See "Domestic Hot Water Pipe Insulation Thickness" table below.

DOMESTIC HOT WATER PIPE INSULATION THICKNESS				
SUPPLY WATER TEMP °F	NON-CIRCULATING RUNOUTS UP TO 1"	CIRCULATING MAINS AND BRANCHES		
		UP TO 1 1/4"	1 1/2" & 2"	OVER 2"
170-180	1"	1"	1 1/2"	2"
140-160	1"	1"	1"	1 1/2"
100-130	1"	1"	1"	1"

Note:

1. The above table is only applicable to insulations in the conductivity range of 0.23 to 0.25. For insulation outside these conductivity ranges, the minimum thickness (T) shall be determined by the following calculation and the calculation submitted for approval:

$$T = r \{ (1 + t/r)^{K/k} - 1 \}$$

T = Thickness

r = Actual outside radius of pipe (in.)

t = Insulation thickness per the above table

K = Conductivity of alternate material

k = Upper value of the Conductivity Range per the above table

END OF SECTION

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SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.

B. Related Section:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and fittings.
2. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 PERFORMANCE REQUIREMENTS

- A.** Provide components and installation capable of producing domestic water piping systems with 80 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A.** Product Data: For pipe, tube, fittings, and couplings.
- B.** Water Sample Reports: Specified in Part 3 "Cleaning" Article.
- C.** Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A.** Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B.** Comply with NSF 61 and NSF 372 for potable domestic water piping and components.
- C.** Installer Qualifications:

1.5 PROJECT CONDITIONS

- A.** Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Copper or Bronze Pressure-Seal Fittings:
1. Manufacturers:
 - a. Elkhart Products ("Apolloexpress").
 - b. NIBCO Inc. ("Press System").
 - c. Viega ("ProPress").
 2. Housing: Copper.
 3. O-Rings and Pipe Stops: EPDM.
 4. Tools: Manufacturer's special tools.
 5. Minimum 200-psig working-pressure rating at 250 deg F.
 6. Smart Connect feature to guarantee identification of un-pressed connections during the testing process.
 7. Grooved-Joint Copper-Tube Appurtenances:
 - a. Manufacturers:
 - 1) Anvil International.
 - 2) Shurjoint Piping Products.
 - 3) Victaulic Company.
 - b. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include rigid angled bolt pad design, ferrous housing sections, flush-seal grade E or installation-ready grade EHP gasket suitable and NSF 61 and NSF 372 approved for cold and hot water, and bolts and nuts.
- C. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

- 1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Sheet or Tube.
- C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.
- D. Color: Black.

2.5 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers:

- a. Cascade Waterworks Manufacturing.
- b. Dresser, Inc.; Dresser Piping Specialties.
- c. Ford Meter Box Company, Inc. (The).
- d. JCM Industries.
- e. Romac Industries, Inc.
- f. Smith-Blair, Inc; a Sensus company.
- g. Viking Johnson; c/o Mueller Co.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Manufacturers:
 - a. EPCO Sales, Inc.
 - b. Hart Industries International, Inc.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - d. Zurn Plumbing Products Group; Wilkins Water Control Products.
 - 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Kits:
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- D. Dielectric Couplings:
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 - 2. Description:

- a. Galvanized-steel coupling.
- b. Pressure Rating: 300 psig at 225 deg F.
- c. End Connections: Female threaded.
- d. Lining: Inert and noncorrosive, thermoplastic.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
- E. Install shutoff valve, hose-end drain valve, strainer and pressure gage inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- F. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- J. Install piping adjacent to equipment and specialties to allow service and maintenance.
- K. Install piping to permit valve servicing.
- L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- M. Install piping free of sags and bends.

- N. Install fittings for changes in direction and branch connections.
- O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- P. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- Q. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints:
 - 1. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
 - 2. Sealing element shall be verified for the intended use.
 - 3. Tube ends shall be cut on a right angle (square) to the tube.
 - 4. Tube ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the tube end with a clean rag.
 - 5. Visually examine the fitting sealing element to ensure there is no damage, and it is properly seated into the fitting.
 - 6. Utilizing an Insertion Depth Inspection Gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the tube fully into the fitting and mark the tube wall at the face of the fitting.
 - 7. Always examine the tube to ensure it is fully inserted into the fitting prior to pressing the joint.
 - 8. Pressure-seal fittings ½-inch thru 4-inch shall be joined using appropriate sized tools.
 - 9. Pressure-seal fittings shall be installed according to the most current edition of the Manufacturer's installation guidelines.
- F. Grooved Joints: Pipe: Roll groove pipe with grooving tools specifically designed for pipe material. Assemble coupling with housing, gasket, lubricant, and bolts. Join pipe and grooved-end fittings according to AWWA C606 for roll-grooved joints.

1. All grooved components (including couplings, fittings, valves and accessories) to be supplied by one manufacturer. Grooving tools shall be of the same manufacturer as the groove components.
 2. Grooving tools shall be equipped with roll sets specifically designed for pipe material. (Flaring of tube or fitting ends to accommodate IPS sized couplings is not permitted.)
 3. A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. Factory representative shall periodically visit the job site and review installation. Contractor shall remove and replace any improperly installed products.
- G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems and provide Dielectric isolator.
- 3.4 VALVE INSTALLATION
- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.
- C. Install hose end drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
- D. Install automatic balancing valves in each hot-water circulation return branch. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for automatic balancing valves.
- E. Install automatic balancing valves with a strainer upstream and a check valve immediately downstream.
- 3.5 TRANSITION FITTING INSTALLATION
- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
1. NPS 2 and Larger: Sleeve-type coupling.
- 3.6 DIELECTRIC FITTING INSTALLATION
- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings, nipples or unions.

- C. Dielectric Fittings for NPS 2-1/2: Use dielectric flange kits.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Perform the following tests on pressure-seal piping:

1. After fittings have been installed a "two step test" shall be followed.
 - a. Pressurize the system with application appropriate test medium, water between 15 and 85 psi, or air/dry nitrogen between .5 and 45 psi.
 - b. Check the pressure gauge for pressure loss.
 - c. If the system does not hold pressure, walk the system and check for un-pressed fittings.
 - d. Should an un-pressed fitting/s be identified, ensure the tube is fully inserted into the fitting, and properly marked, prior to pressing the joint.
 - e. After appropriate repairs have been made, retest the system per local code, or specification requirements, not to exceed 600 psi with water.

E. Domestic water piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:

- 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples for testing in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

3.13 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water, building-service entrance piping, NPS 8 and smaller, shall be the following:
 1. Mechanical-joint, ductile-iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints.
- D. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
 1. Soft copper tube, ASTM B 88, Type k; No joints below grade.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be **[one of]** the following:
 1. Hard copper tube, ASTM B 88, Type L ASTM B 88; cast- or wrought- copper solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal fittings; and pressure-seal joints.
- F. Aboveground domestic water piping, NPS 2 1/2 and larger, shall be one of the following:
 1. Hard copper tube, ASTM B 88, Type L ASTM B 88; cast- or wrought- copper solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal fittings; and pressure-seal joints.
 3. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints.
- G. Non-Potable-Water Piping: Use same materials as domestic water piping

3.14 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly valves with flanged **[or grooved]** ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly valves with flanged [**or grooved**] ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Automatic balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

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SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. ~~[Provide plumbing fixtures and drains as listed on Drawings and described herein. Fixture numbers are Zurn products. All products to be purchased from Ferguson Enterprises.]~~
- B. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
 2. Backflow preventers.
 3. Water pressure-reducing valves.
 4. Balancing valves.
 5. Thermostatic mixing valves.
 6. Strainers.
 7. Outlet boxes.
 8. Hose bibbs.
 9. Wall hydrants.
 10. Ground hydrants.
 11. Drain valves.
 12. Water hammer arresters.
 13. Air vents.
 14. Trap-seal primer valves.
 15. Electrical trap-seal primer systems.
- C. Related Sections include the following:
1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
 2. Division 22 Section "Domestic Water Piping" for water meters.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For domestic water piping specialties to include operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
 - 3. NSF Compliance: NSF 61-G for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: **[Rough bronze] [Chrome plated]**.
- B. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. MIFAB, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Woodford Manufacturing Company.
 - e. Zurn Plumbing Products Group.
 - 2. Standard: ASSE 1011.
 - 3. Body: Brass, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or Rough bronze.
- C. Pressure Vacuum Breakers:

1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Beeco, LLC.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:
 - a. Valves: Ball type, on inlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Woodford Manufacturing Company.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:
 - a. Valves: Ball type, on inlet.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Honeywell Water Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Body: Bronze.
5. End Connections: Union or solder joint.
6. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Beeco, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; **[rising stem gate valve] [outside screw and yoke gate-type]** with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Pressure Regulators:

1. Manufacturers:
 - a. Conbraco Industries, Inc.
 - b. Honeywell Water Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Beeco, LLC.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Provide integral bypass on PRV serving booster heaters.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water Control Valves:

1. Manufacturers:

- a. CLA-VAL Automatic Control Valves.
 - b. OCV Control Valves.
 - c. Watts Industries, Inc.; Watts ACV.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Beeco, LLC.
- 2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
 - 3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
 - 4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - a. Pattern: Angle or Globe-valve design.
 - b. Trim: Stainless steel.
 - 5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.4 BALANCING VALVES

A. Automatic Balancing Valves:

- 1. Manufacturers:
 - a. Flow Design, Inc.
 - b. Griswold Controls
- 2. Type: Ball valve with two readout ports and stainless steel flow regulating cartridge.
- 3. Body: Brass.
- 4. Size: Same as connected piping, but not larger than NPS 2.
- 5. Pressure Rating: 400-psig minimum CWP.
- 6. Ball: Chrome-plated brass.
- 7. Seats and Seals: Replaceable.
- 8. End Connections: Solder joint or threaded.
- 9. Handle: Vinyl-covered steel.
- 10. Accuracy: plus or minus 5%

2.5 THERMOSTATIC MIXING VALVES

A. Thermostatic, Water Mixing Valves:

- 1. Manufacturers:
 - a. Armstrong International, Inc. (RADA)
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Symmons Industries, Inc.
- 2. Standard: ASSE 1017.
- 3. Pressure Rating: 125 psig.
- 4. Type: **[Exposed-mounting] [Cabinet-type]**, thermostatically controlled water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Valve Finish: [**Chrome plated**] [**Polished, chrome plated**] [**Rough bronze**].
10. Piping Finish: [**Chrome plated**] [**Copper**].
11. Cabinet: Factory-fabricated, stainless steel, for [**recessed**] [**surface**] mounting and with hinged, stainless-steel door.

B. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:

1. Manufacturers:
 - a. Leonard Valve Company.
 - b. Powers; a Watts Industries Co.
 - c. Symmons Industries, Inc.
 - d. Armstrong International, Inc. (RADA)
2. Description: Factory-fabricated, [**cabinet-type**] [**exposed-mounting**], thermostatically controlled, water-mixing-valve assembly in [**two**] [**three**]-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
4. Intermediate-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
5. Small-Flow Parallel: Thermostatic water mixing valve.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
7. Water Pressure Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.
9. Cabinet: Factory-fabricated, stainless steel, for [**recessed**] [**surface**] mounting and with hinged, stainless-steel door.
10. Thermostatic Mixing Valve and Water Regulator Finish: [**Chrome plated**] [**Polished, chrome plated**] [**Rough bronze**].
11. Piping Finish: [**Chrome plated**] [**Copper**].

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company.
 - b. Powers.
 - c. Watts; a Watts Water Technologies company.
 - d. Zurn Industries, LLC.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers:
 - a. Acorn Engineering Company.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. IPS Corporation. (Guy Gray)
 - d. Oatey.
 - e. Symmons Industries, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - h. Zurn Plumbing Products Group.
2. Mounting: Recessed.
3. Material and Finish: **[Epoxy-painted-steel] [Stainless-steel]** box and faceplate.
4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes:

1. Manufacturers:
 - a. Acorn Engineering Company.
 - b. IPS Corporation. (Guy Gray)
 - c. Oatey.
2. Mounting: Recessed.
3. Material and Finish: **[Epoxy-painted-steel] [Stainless-steel]** box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Refer to Plumbing Fixture Schedule on drawings for finishes.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group.
2. Standard: ASME A112.21.3M for **[concealed]** **[exposed]**-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 [or NPS 1].
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Operating Keys(s): One with each wall hydrant.
11. Refer to Plumbing Fixture Schedule on drawings for finishes.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers:
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group.

2. Standard: ASME A112.21.3M for [concealed] [exposed]-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlets: NPS 3/4 or NPS 1.
7. Outlet: Concealed.
8. Box: Deep, flush mounting with cover.
9. Vacuum Breaker: Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052 and with garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Keys(s): One with each wall hydrant.
11. Refer to Plumbing Fixture Schedule on drawings for finishes.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Body: Copper alloy.
4. Ball: Chrome-plated brass.
5. Seats and Seals: Replaceable.
6. Handle: Vinyl-covered steel.
7. Inlet: Threaded or solder joint.
8. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. PPP Inc.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.12 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.

2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Inlet and Vent Outlet End Connections: Threaded.

2.13 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Distribution box as required.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.14 ELECTRIC TRAP-SEAL PRIMER SYSTEMS

A. Electric Trap-Seal Primer Systems:

1. Manufacturers:
 - a. PPP Inc.
 - b. MIFAB, Inc.
2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: **[Recessed]** **[Surface]**-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: as indicated on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 2. Do not install bypass piping around backflow preventers.
- C. Install water pressure regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- E. Install balancing valves in locations where they can easily be adjusted.
- F. Install thermostatic mixing valves with check stops or shutoff valves and strainers on inlets and with shutoff valve on outlet.
 - 1. Install thermometers on inlets and outlet and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- I. Install water hammer arresters in water piping according to PDI-WH 201 and drawings.
- J. Install air vents at high points of water piping. Install drain piping and discharge to floor drain.
- K. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- L. Install electric trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check backflow-prevention assemblies.
 - 5. Pressure-reducing valves.
 - 6. Automatic balancing valves.
 - 7. Thermostatic mixing valves.
 - 8. Manifold, thermostatic mixing valve assemblies.
 - 9. Outlet boxes.
 - 10. Supply-type, trap-seal primer valves.
 - 11. Electric trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and vacuum breaker assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Confirm flow rate and direction of flow for automatic balancing valves.
- C. Set field-adjustable temperature set points of thermostatic mixing valves.

END OF SECTION

SECTION 221123

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic hot-water circulation:
 - 1. Close-coupled, horizontally mounted, in-line centrifugal pumps.
 - 2. Close-coupled, vertically mounted, in-line centrifugal pumps.
- B. Related Sections include the following:
 - 1. Division 22 Section "Domestic-Water Packaged Booster Pumps" for booster systems.

1.2 SUBMITTALS

- A. Simultaneous Action Submittals: Domestic water pumps Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of plumbing equipment submittals is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- B. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- C. Shop Drawings:
 - 1. Diagram power, signal, and control wiring.
 - 2. Short-circuit current rating of equipment assembly.
- D. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Pump Manufacturers:

- 1. Armstrong Pumps Inc.
- 2. Aurora Pump; Pentair Pump Group (The).
- 3. Bell & Gossett Domestic Pump; ITT Industries.
- 4. Grundfos Pumps Corp.
- 5. Paco Pumps, Inc.
- 6. Sterling Peerless; Sterling Fluid Systems Group.
- 7. Taco, Inc.
- 8. Thrush Company, Inc.
- 9. Weinman Div.; Crane Pumps & Systems.

2.2 Ratings:

- A. Short-Circuit Current: Match rating of overcurrent protective device serving domestic water pumps.
- B. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.3 CLOSE-COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, horizontally mounted, in-line centrifugal pumps as defined in ANSI HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.

- a. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
- b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
- c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
- d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
- e. Bearings: Oil-lubricated; bronze-journal or ball type.

2. Shaft Coupling: Rigid type if pump is provided with coupling.
3. Motor: Single speed, with grease-lubricated ball bearings. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

B. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

~~2.4 CLOSE-COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS~~

~~A. Description: Factory assembled and tested, overhung impeller, single stage, close-coupled, vertically mounted, in-line centrifugal pumps as defined in ANSI HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted vertically.~~

~~1. Pump Construction: Bronze fitted.~~

- ~~a. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.~~
- ~~b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.~~
- ~~c. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.~~
- ~~d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.~~
- ~~e. Bearings: Oil-lubricated; bronze journal or ball type.~~

~~2. Shaft Coupling: Rigid type if pump is provided with coupling.~~

~~3. Motor: Single speed, with grease-lubricated ball bearings; and directly mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."~~

~~a. Lifting and Supporting Lug: Factory mounted in top of motor enclosure.~~

~~B. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS~~

2.5 CONTROLS

A. Aquastats: Electric; adjustable for control of hot-water circulation pump.

1. Manufacturers:

- a. Honeywell International, Inc.
- b. Square D.
- c. White-Rodgers Div.; Emerson Electric Co.

2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
3. Range: 65 to 200 deg F.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V, ac.
7. Settings: Start pump at 115 deg F and stop pump at 120 deg F.

B. Timers: Electric time clock for control of hot-water circulation pump.

1. Manufacturers:
 - a. Honeywell International, Inc.
 - b. Intermatic, Inc.
 - c. Johnson Controls, Inc.
 - d. TORK.
2. Type: Programmable, seven-day clock with manual override on-off switch.
3. Enclosure: Suitable for wall mounting.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V, ac.
7. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

C. Time Delay Relay: Control for hot-water storage tank circulation pump.

1. Manufacturers:
 - a. Honeywell International, Inc.
 - b. Intermatic, Inc.
 - c. Johnson Controls, Inc.
 - d. Square D.
 - e. White-Rodgers Div.; Emerson Electric Co.
2. Type: Adjustable time delay relay.
3. Range: Up to five minutes.
4. Setting: Five minutes.
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: 120 V, ac.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

2.6 BUILDING-AUTOMATION-SYSTEM INTERFACE

- A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
 1. On-off status of each pump.
 2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with ANSI HI 1.4.

- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install close-coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.
- E. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.3 CONTROL INSTALLATION

- A. Install immersion-type aquastats in hot-water return piping.
- B. Install timers.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
 - 1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
 - 2. Install pressure gages at suction and discharge of pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect aquastats and timers to pumps that they control.
- F. Interlock pump with water heater burner and time delay relay.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.

3. Clean strainers on suction piping.
4. Set aquastats and timers for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 221123.13

DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes variable-speed, multiplex, packaged booster pumps for domestic water piping systems.
- B. Related Sections include the following:
 - 1. Division 22 Section "Domestic Water Pumps" for domestic water circulation pumps.
 - 2. Division 23 Section "Variable-Frequency Drives"
 - 3. Division 26 Section "Variable-Frequency Drives"

1.2 SUBMITTALS

- A. Product Data: For each packaged booster pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: For packaged booster pumps and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
 - 2. Wiring Diagrams: Detail power, signal, and control wiring.
 - 3. Short-circuit current rating of controller assembly.
- C. Operation and Maintenance Data: For each packaged booster pump to include in emergency, operation, and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged booster pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASME Compliance: Comply with ASME B31.9 for piping.
- D. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

1. The pumping package components shall be certified by an approved independent testing and certification organization as being compliant with the requirements of NSF/ANSI 61 for potable drinking water and NSF-61 Annex G for low lead content.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 VARIABLE-SPEED, MULTIPLEX BOOSTER PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ~~Bell & Gossett; a Xylem brand.~~
2. Canariis Corporation.
3. Grundfos Pumps Corporation U.S.A.
4. SyncroFlo, Inc. ("Iron heart")
5. TIGERFLOW Systems, Inc.

- B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

- C. System Working-Pressure Rating: 150 psig minimum.

- D. Pumps:

1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
2. Casing: Radially split; ~~bronze~~ cast iron ~~stainless steel~~.
3. Impeller: Closed, ASTM B 584 cast bronze/ stainless steel; statically and dynamically balanced and keyed to shaft.
4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
5. Seal: Mechanical.
6. Orientation: Mounted horizontally or vertically.

- ~~E. Pumps:~~

1. ~~Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump. Include back-pullout design.~~

2. ~~Casing: Radially split; bronze cast iron stainless steel.~~
3. ~~Impeller: Closed, ASTM B 584 cast bronze, stainless steel; statically and dynamically balanced and keyed to shaft.~~
4. ~~Shaft and Shaft Sleeve: Stainless steel shaft, with copper alloy shaft sleeve and deflector.~~
5. ~~Seal: Mechanical.~~
6. ~~Bearing: Grease lubricated ball type.~~
7. ~~Coupling: Flexible, with metal guard.~~

F. ~~Pumps:~~

1. ~~Type: In line, single stage as defined in HI 1.1 1.2 and HI 1.3 for in line, single stage, close coupled, overhung impeller, centrifugal pump.~~
2. ~~Casing: Radially split; [bronze] [cast iron] [stainless steel].~~
3. ~~Impeller: Closed, [ASTM B 584 cast bronze] [stainless steel]; statically and dynamically balanced and keyed to shaft.~~
4. ~~Shaft and Shaft Sleeve: Stainless steel shaft, with copper alloy shaft sleeve.~~
5. ~~Seal: Mechanical.~~
6. ~~Bearing: Grease lubricated ball type.~~

G. ~~Pumps:~~

1. ~~Type: Vertical, multistage as defined in HI 1.1 1.2 and HI 1.3 for in line, multistage, separately coupled, overhung impeller, centrifugal pump.~~
2. ~~Casing: Cast iron or steel base and stainless steel chamber.~~
3. ~~Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.~~
4. ~~Shaft: Stainless steel.~~
5. ~~Seal: Mechanical.~~
6. ~~Bearing: Water lubricated sleeve type.~~

H. ~~Pumps:~~

1. ~~Type: Vertical, multistage can, as defined in HI 2.1 2.2 and HI 2.3 for in line, barrel or can, lineshaft, vertical pump.~~
2. ~~Impeller: Closed, ASTM B 584, cast bronze or 304/316 stainless steel; statically and dynamically balanced and keyed to shaft.~~
3. ~~Bowls: [Epoxy coated cast iron] [stainless steel].~~
4. ~~Shaft: Stainless steel.~~
5. ~~Seals: Mechanical and stuffing box types.~~
6. ~~Bearings: Water lubricated bushing type.~~

I. Motors: Single speed, with grease-lubricated, ball-type bearings. Select motors that will not overload through full range of pump performance curve.

J. Piping: ASME B31.9 for piping materials and installation. Copper tube and copper fittings, Stainless-steel pipe and fittings, Stainless-steel pipe and fitting headers and copper tube and copper fittings between headers and pump. Piping, including valves and other components, may have grooved ends for grooved joints.

K. Valves:

1. Shutoff Valves NPS 2 and Smaller: two-piece, full-port ball valve, in each pump's suction and discharge piping.
2. Shutoff Valves NPS 2-1/2 and Larger: lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.

3. Check Valves NPS 2 and Smaller: Silent or swing type in each pump's discharge piping.
 4. Check Valves NPS 2-1/2 and Larger: Silent type in each pump's discharge piping.
 5. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.
- L. Dielectric Fittings: With insulating material isolating joined dissimilar metals.
- M. Control Panel: Factory installed and connected as an integral part of booster pump complying with NEMA ICS 2 and UL 508; automatic for multiple-pump, variable-speed operation, with load control and protection functions.
1. Control Logic: Solid-state system with transducers, programmable microprocessor, VFD, and other devices in controller. Install VFD for pump motors larger than 25 hp in separate panel; same type as motor control panel enclosure.
 2. Motor Controller: NEMA ICS 2, variable-frequency, solid-state type.
 - a. Control Voltage: 24 or 120-V ac, with integral control-power transformer.
 3. Enclosure: NEMA 250, ~~Type 1 Type 3R Type 4 Type 12.~~
 4. Motor Overload Protection: Overload relay in each phase.
 5. Starting Devices: Hand-off-automatic selector switch for each pump in cover of control panel, plus pilot device for automatic control.
 - a. Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
 - b. ~~Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.~~
 6. Pump Operation and Sequencing: Pressure-sensing method ~~[or] [flow-sensing method]~~
~~[Pressure-sensing method for lead pump and flow-sensing method for lag pumps].~~
 - a. Time Delay: Controls pump on-off operation; adjustable from 1 to 300 seconds.
 7. VFD: Voltage-source, pulse-width, modulating-frequency converter for each pump.
 8. Manual Bypass: Magnetic contactor arranged to transfer to constant-speed operation upon VFD failure.
 9. Instrumentation: Suction and discharge pressure gages.
 10. Lights: Running light for each pump.
 11. Alarm Signal Device: Sounds alarm when backup pumps are operating.
 - a. Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with automatic ~~[manual]~~-reset.
 12. Thermal-bleed cutoff.
 13. Low-suction-pressure, Water-storage-tank, low-level cutout.
 14. High-suction-pressure cutout.
 15. High-discharge-pressure cutout.
 16. Short Circuit Current Rating
 - a. Short-Circuit Current: Match rating of overcurrent protective device serving domestic water packaged booster pumps.
 - b. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

- N. Base: Structural steel.
- O. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.
- P. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.2 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Anamet, Inc.
 - 2. Flex-Hose Co., Inc.
 - 3. Hyspan Precision Products, Inc.
 - 4. Metraflex, Inc.
 - 5. Unaflex Inc.
- B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include ~~[150-psig]~~ 175-psig minimum working-pressure rating and ends according to the following:
 - 1. Provide ends to match pump or system connections and pressure rating.

2.3 FACILITY MANAGMENT SYSTEM INTERFACE

- A. The following communication features shall be provided to the Building Automation System via an onboard RS-485 port utilizing Johnson Controls Metasys N2, Modicon Modbus or BACnet MS/TP protocol:
 - 1. All sensor process variables
 - 2. Individual zone setpoints
 - 3. Individual pump failure
 - 4. Individual pump on/off status
 - 5. Individual VFD on/off status
 - 6. VFD speed
 - 7. Individual VFD Failure
 - 8. Individual sensor failure

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for packaged booster pumps to verify actual locations of connections before booster pump installation.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for packaged booster pumps. Refer to Division 22 Section "Common Work Results for Plumbing."

- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 BOOSTER PUMP INSTALLATION

- A. Install packaged booster pumps level on concrete bases with access for periodic maintenance including removal of pumps, motors, impellers, couplings, and accessories.
 - 1. Do not dismantle packaged booster pumps or remove individual components.
- B. Vibration Isolation: Install on spring isolators. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- C. Support connected domestic water piping so weight of piping is not supported by packaged booster pumps.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic water piping to packaged booster pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge headers.
 - 1. Install flexible connectors on piping connections to unit suction and discharge headers. Install flexible connectors same size as piping.
 - 2. Install shutoff valves on piping connections to each booster pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. General-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 3. Install union or flanged connections on pump suction and discharge headers at connection to domestic water piping.
 - 4. Install piping adjacent to packaged booster pumps to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform the following startup service:
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers if any.
 - 4. Verify that pump controls are correct for required application.
 - 5. Verify that vibration isolator springs are not completely compressed.
- B. Perform the following startup checks for each pump of packaged booster pump unit before starting:

1. Verify bearing lubrication.
 2. Prime pumps by opening suction valves and closing discharge valves, and prepare pumps for operation.
 3. Start motors and Open discharge valves slowly.
 4. Adjust settings.
- C. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This job site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting packaged booster pumps to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

3.6 LABELING AND IDENTIFICATION

- A. Install identifying equipment markers and equipment signs on booster pumps. Labeling and identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged booster pumps. Refer to Division 01 Section "Demonstration and Training"
- B. The system manufacturer's factory qualified representative shall be capable of providing on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

END OF SECTION

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SECTION 22 1316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sanitary Sewerage Pumps."
 - 2. Division 22 Section "Chemical Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
 - 3. Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. NBR: Acrylonitrile-butadiene rubber.
- D. PE: Polyethylene plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 50 psig.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:
- C. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall be American manufactured and bear label, stamp, or other markings of specified testing agency.
- B. All cast iron Piping and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed with NSF international.
- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: Assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310 and ASTM C 1277, with stainless steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve & bear the NSF Trademark.
 - a. Manufacturers:
 - 1) ANACO.
 - 2) Mission Rubber Co.
 - 3) Tyler Pipe; Soil Pipe Div.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

D. Grooved-Joint Systems:

1. Manufacturers:
 - a. Anvil International.
 - b. Victaulic Company.
2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Grooved-Joint Systems:

1. Manufacturers:
 - a. Victaulic Company.
2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.5 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

C. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.6 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

2.7 DRIP PANS

A. Of not less than 14-gauge galvanized steel with raised sides and galvanized steel pipe nipple drains welded in place at low points.

2.8 ENCASEMENT FOR FERROUS PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Sheet or Tube.

C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.

D. Color: Black.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. PVC piping shall not be used within occupied spaces or plenums of occupied spaces, ***unless separated and protected from the plenum by a barrier conforming to ASTM E84 flame and smoke spread index to perform at not less than 25 / 50. Final means of separation to be approved by AHJ.***

C. Aboveground, soil and waste piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

3. Steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.
5. **Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.**

D. Aboveground, vent piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.
5. **Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.**

E. Underground, soil, waste, and vent piping shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

F. Aboveground sanitary-sewage force mains shall be any of the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Steel pipe, pressure fittings, and threaded joints.

G. Underground sanitary-sewage force mains shall be any of the following:

1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.
 - a. Include grooved-joint system fittings and couplings and grooved joints where indicated.
3. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

3.2 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

- F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install soil and waste drainage and vent piping downward in direction of flow at the slopes required by local code or Authorities Having Jurisdiction, unless otherwise indicated on drawings.
- K. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- M. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- O. Hubless cast-iron piping 6" and larger shall be restrained at any direction change using blocks, rods, bracing or other suitable methods.
- P. Provide drip pans under waste lines concealed above operating, cysto and delivery rooms, cath labs, nurseries, food preparation centers, food serving facilities, food storage areas, central services, electronic data processing areas, electric and telecommunication closets, and other sensitive areas, or as shown on the plans. Pans shall be of galvanized steel, arranged to drain outside these areas, or as noted on Drawings.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

- C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- E. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- F. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
 - 1. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- D. Support vertical piping and tubing at base and at each floor.
- E. Install supports for vertical cast-iron soil piping every 15 feet.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install supports for vertical stainless-steel piping every 10 feet.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main or sanitary manhole.
 - 2. Sewage Pumps: To sewage pump discharge.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

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SECTION 22 1319

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Trench drains.
 - 4. Roof flashing assemblies.
 - 5. Through-penetration firestop assemblies.
 - 6. Miscellaneous sanitary drainage piping specialties.
 - 7. Flashing materials.
- B. Related Sections include the following:
 - 1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
 - 2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
 - 3. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.
 - 4. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

1.2 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories:
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, Refer to table for area and provide the product indicated or a comparable product by one of the following:
 - 1) Linoleum Floors: J.R. Smith Series 4140 - round top with insert
 - 2) Carpeted Floors: J.R. Smith Series 4240-Y - round with carpet marker
 - 3) Exterior: J. R. Smith 4240 - round with cast iron cover
 - 4) Wall: J.R. Smith Series 4710
 - 5) Quarry Floor: J.R. Smith Series 4053-PB - square bronze top
 - 6) Ceramic Floor: J.R. Smith Series 4053-NB - square nickel bronze top
 - 7) Concrete Floors: J. R. Smith Series 4100 – round galvanized cast iron top.
 - 8) Truck/Loading Dock Areas: J. R. Smith Series 4231 – ductile iron top.
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Body Material: cast-iron as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.2 FLOOR DRAINS AND FLOOR SINKS

A. Floor Drains and Floor Sinks:

1. Manufacturers:
 - a. Josam Company; Josam Div.

- b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Light Commercial Operation.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.3.
 - 3. Refer to schedule on drawings

2.3 TRENCH DRAINS

A. Trench Drains:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.3 for trench drains.
- 3. Material: Ductile or gray iron.
- 4. Flange: Anchor.
- 5. Clamping Device: Required.
- 6. Outlet: End.
- 7. Grate Material: Stainless steel.
- 8. Grate Finish: Not required.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

- B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Hub Drain:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: as indicated on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains/sinks at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains/sinks for easy access and maintenance.
 2. Set floor drains/sinks below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain/sink flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains/sinks connected to sanitary building drain, unless otherwise indicated.
- F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

- I. Assemble open drain fittings and install with top of hub 1 inch above floor.
- J. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- K. Install floor-drain/sink, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- O. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- P. Install wood-blocking reinforcement for wall-mounting-type specialties.
- Q. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- R. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221323

SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of interceptors outside the building:

1. Grease interceptors.
2. Oil interceptors.
3. Sand interceptors.
4. Sediment interceptors.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PP: Polypropylene plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast concrete interceptor indicated.
1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
- C. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Interceptors.
 2. Piping connections. Include size, location, and elevation of each.
 3. Interface with underground structures and utility services.

1.4 PROJECT CONDITIONS

- A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Owner's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

- A. Grease Interceptors: Precast concrete complying with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
1. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.
 2. Structural Design Loads:
 - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."
- B. Grease Interceptor Capacity and Characteristics: REFER TO DRAWINGS

2.2 OIL INTERCEPTORS

- A. Oil Interceptors: Precast concrete comply with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
1. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.
 2. Structural Design Loads:
 - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Include indented top design with lettering cast into cover, using wording equivalent to "OIL INTERCEPTOR."

6. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-Oil Piping."
- B. Oil Interceptors: Factory-fabricated, cast-iron or steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB Manufacturing Inc.
 - c. Rockford Sanitary Systems, Inc.
 - d. Smith, Jay R. Mfg. Co.
 - e. Wade Div.; Tyler Pipe.
 - f. Watts Industries, Inc.
 - g. Zurn Specification Drainage Products; Zurn Plumbing Products Group.
 2. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
 3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
 4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, [**A-03, walkway**] <Insert other> load.
 5. Protective Coating: Factory-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all ferrous surfaces, except bucket or strainer, unless otherwise indicated.
 6. Waste-oil storage tank and piping are specified in Division 23 Section "Facility Fuel-Oil Piping."
- C. Oil Interceptor Capacity and Characteristics: REFER TO DRAWINGS

2.3 SAND INTERCEPTORS

- A. Description: Factory-fabricated, cast-iron or steel body and inlet grate; with settlement chamber and removable basket or strainer.
1. Manufacturers:
 - a. MIFAB Manufacturing Inc.
 - b. Rockford Sanitary Systems, Inc.
 - c. Smith, Jay R. Mfg. Co.
 - d. Wade Div.; Tyler Pipe.
- B. Outlet Piping Connection: Hub, hubless, or threaded, unless otherwise indicated.
- C. Grate: Cast iron or steel with reinforcement to provide ASTM C 890, [**A-03, walkway**] <Insert other> load.
- D. Protective Coating: Factory-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior ferrous surfaces except basket or screens.
- E. Sand Interceptor Capacity and Characteristics: REFER TO DRAWINGS

2.4 SEDIMENT INTERCEPTORS

- A. Sediment Interceptors: Precast concrete comply with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
1. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.
 2. Structural Design Loads:
 - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor sidewalls, for each pipe connection.
 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Include indented top design with lettering cast into cover, using wording equivalent to the following:
 - 1) Sediment Interceptors in Sanitary or storm Sewerage System: "SEDIMENT INTERCEPTOR."
 6. Cast Ferrous Gratings: Frame and flat grate with small-square or short slotted drainage openings.
 - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
 - c. Minimum Size: 24 by 24 inches, unless otherwise indicated.
 - d. Free Area: Approximately 50 percent, unless otherwise indicated.
- B. Sediment Interceptors: Factory-fabricated, cast-iron or steel body and cover; with settlement chambers; baffles; and removable basket, strainer, or screens.
1. Manufacturers:
 - a. Josam Company.
 - b. MIFAB Manufacturing Inc.
 - c. Rockford Sanitary Systems, Inc.
 - d. Smith, Jay R. Mfg. Co.
 - e. Wade Div.; Tyler Pipe.
 - f. Watts Industries, Inc.
 - g. Zurn Specification Drainage Products; Zurn Plumbing Products Group.
 2. Inlet and Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
 3. Extension: Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.
 4. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, [**A-03, walkway**] <Insert other> load.
 5. Protective Coating: Factory-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all ferrous surfaces except basket or strainer.

- C. Sediment Interceptor Capacity and Characteristics: REFER TO DRAWINGS

2.5 PRECAST CONCRETE MANHOLE RISERS

- A. Precast Concrete Manhole Risers: ASTM C 913, 36-inch ID. Include rubber-gasketed joints.
 - 1. Structural Design Loads:
 - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
 - 2. Length: From top of underground concrete structure to grade.
 - 3. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
 - 4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
 - 5. Gaskets: ASTM C 443, rubber.
 - 6. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
- B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
- C. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all exterior and interior concrete surfaces.
- D. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 22 Section "Earth Moving."

3.2 INSTALLATION

- A. Install interceptor inlets and outlets at elevations indicated.
- B. Install precast concrete interceptors according to ASTM C 891. Set level and plumb.
- C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
- D. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inches above finish surface elsewhere, unless otherwise indicated.
- E. Set tops of grating frames and grates flush with finished surface.

- F. Clean and prepare concrete surfaces to be field painted. Remove loose efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:
 - 1. Precast Concrete Interceptors: All exterior and interior.
- G. Clean and prepare metal surfaces to be field painted according to SSPC- PA 1. Paint the following metal surfaces according to SSPC-PA 1 and SSPC-Paint 16:
 - 1. Metal Interceptors: All surfaces except baskets, screens, and strainers.
 - 2. Do not paint metal surfaces with factory-applied, corrosion-resistant coating.
- H. Set metal interceptors level and plumb.
- I. Set tops of metal interceptor covers flush with finished surface in pavements. Set tops 3 inches above finish surface elsewhere, unless otherwise indicated.
- J. Prepare and paint metal components, to be field painted, according to SSPC-Paint 16.
- K. Install piping and oil storage tanks according to Division 23 Section "Facility Fuel-Oil Piping."
- L. Repair and restore protective coatings to original condition.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

- A. Identification materials and installation are specified in Division 22 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
 - 1. Use warning tapes or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION

SECTION 221413

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. ~~{Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.}~~
- B. This Section includes the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- C. Related Sections include the following:
 - 1. Division 22 Section "Sump Pumps."
 - 2. Division 31 Section "Earth Moving".
 - 3. Division 33 Section "Storm Utility Drainage Piping."
 - 4. Division 22 Section "Common Work Results for Plumbing."
 - 5. Division 22 Section "General-Duty Valves for Plumbing Piping."

1.2 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 100 psig.
- B. **Seismic Performance:** Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. **Shop Drawings:**
 - 1. **Design Calculations:** Signed and sealed by a qualified professional engineer for selecting seismic restraints.

- C. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall be American manufactured and bear label, stamp, or other markings of specified testing agency.
- B. All cast iron Piping and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed with NSF international.
- C. For below grade applications comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Extra-Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: Assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) Husky SD 4000
 - 2) Clamp-All Corp.-125
 - 2. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) MG Piping Products Co.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight. Include ends matching joining method.

- B. Drainage Fittings: ASME B16.12, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
 - 1. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 2. Cast-Iron Flanges: ASME B16.1, Class 125.
 - 3. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.
- D. Grooved-Joint Systems:
 - 1. Manufacturers:
 - a. Anvil International.
 - b. Victaulic Co. of America.
 - c. Ward Manufacturing, Inc.
 - 2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, malleable-iron casting; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.4 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint Systems:
 - 1. Manufacturers:
 - a. Victaulic Co. of America.
 - b. Ward Manufacturing, Inc.
 - c. Anvil International.
 - 2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 - 3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

2.5 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

2.6 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

- 1. Manufacturers:

- a. Dallas Specialty & Mfg. Co.
 - b. Fernco, Inc.
 - c. Logan Clay Products Company (The).
 - d. Mission Rubber Co.
 - e. NDS, Inc.

- 2. Sleeve Materials:

- a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

- 1. Available Manufacturers:

- a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.

- C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

- 1. Available Manufacturers:

- a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.; DMD Div.
 - c. EBAA Iron Sales, Inc.
 - d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - e. JCM Industries, Inc.
 - f. Romac Industries, Inc.
 - g. Smith-Blair, Inc.
 - h. Viking Johnson.

- 2. Center-Sleeve Material: Manufacturer's standard.
 - 3. Gasket Material: Natural or synthetic rubber.
 - 4. Metal Component Finish: Corrosion-resistant coating or material.

- D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with

AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Available Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products; Star Fittings Div.

2.7 ~~[ENCASEMENT FOR FERROUS PIPING~~

- ~~A. Standard: ASTM A 674 or AWWA C105.~~
- ~~B. Form: Sheet or Tube.~~
- ~~C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.~~
- ~~D. Color: Black.]~~

2.8 DRIP PANS

- A. Of not less than 14-gauge galvanized steel with raised sides and galvanized steel pipe nipple drains welded in place at low points.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. PVC piping shall not be used within occupied spaces or plenums of occupied spaces, ***unless separated and protected from the plenum by a barrier conforming to ASTM E84 flame and smoke spread index to perform at not less than 25 / 50. Final means of separation to be approved by AHJ.***
- C. Aboveground storm drainage piping shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
 3. Steel pipe, drainage fittings, and threaded joints.
 4. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
 5. ***Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.***
- D. Underground storm drainage piping shall be any of the following:
 1. Extra-heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. Dissimilar Pipe-Material Couplings: Flexible, Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- E. Aboveground storm drainage force mains shall be any of the following:
1. Steel pipe, pressure fittings, and threaded joints.
 2. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.
- F. Underground storm drainage force mains shall be any of the following:
1. Steel pipe, pressure fittings, and threaded joints.
 2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.
 3. Pressure pipe couplings if dissimilar pipe materials or piping with small difference in OD must be joined.

3.2 PIPING INSTALLATION

- A. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."
- C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- D. Install underground, steel, force-main piping. **[Install encasement on piping according to ASTM A 674 or AWWA C105.]**
- E. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- G. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- J. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- K. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.
- L. Install force mains at elevations indicated.
- M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- N. Install underground PVC storm drainage piping according to ASTM D 2321.
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- P. Hubless cast-iron piping 6" and larger shall be restrained at any direction change using blocks, rods, bracing or other suitable methods.
- Q. Provide drip pans under waste lines concealed above operating, cysto and delivery rooms, cath labs, nurseries, food preparation centers, food serving facilities, food storage areas, central services, electronic data processing areas, electric and telecommunication closets, and other sensitive areas, or as shown on the plans. Pans shall be of galvanized steel, arranged to drain outside these areas, or as noted on Drawings.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."
- B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. Grooved Joints: Cut groove ends of pipe and assemble grooved ends of pipes, grooved-end fittings, and grooved-end-piping couplings according to AWWA C606.
- E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. Shutoff Valves: Install shutoff valve on each sump pump discharge.
 - 1. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Install gate valve for piping NPS 2-1/2 and larger.

- B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
- C. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type.
 - 2. Install backwater valves in accessible locations.
 - 3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Connect force-main piping to sump pump discharge.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

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SECTION 221415
FACILITY SUB SOIL DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. **[Provide piping, valves, fittings and related products as listed on Drawings and described herein. All products to be purchased from Ferguson Enterprises.]**
- B. This Section includes the following sub soil drainage piping inside and outside the building:
 - 1. Pipe and fittings.
 - 2. Special pipe fittings.
 - 3. Wrapping of piping with geotextile screen material
- C. Related Sections include the following:
 - 1. Division 22 Section "Sump Pumps."
 - 2. Division 31 Section "Earth Moving".
 - 3. Division 33 Section "Storm Utility Drainage Piping."
 - 4. Division 22 Section "Common Work Results for Plumbing."

1.2 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.
- B. PE: Polyethylene

1.3 SUBMITTALS

- A. Product Data: For pipe, fittings, and drainage fabric.
- B. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. For below grade applications comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 Manufacturers:

1. ADS
2. HANCOR

2.2 SUB-SOIL DRAINAGE PIPING

- A. Perforated pipe: ASTM F2648, high density polyethylene conforming with the minimum requirement of cell classifications 424420C, perforated pipe conforming to AASHTO class II perforations, with a smooth interior and annular exterior corrugations. With Bell and spigot fittings or plain end pipe with snap couplings complying with ASTM F2306.
- B. Solid Wall pipe: ADS heavy duty polyethylene pipe with joints of split or snap couplings meeting ASTM F2306.
- C. Filter Wrap: Geotex 401 polypropylene, staple fiber, needlepunched nonwoven geotextile manufactured by Propex Geosynthetics or equal. The material shall be resistant to ultraviolet degradation and to biological and chemical environments normally found in soils and conform to ASTM D-4491, ASTM D-4751 and ASTM D-4355.

2.3 CLEANOUTS

- A. 8" Nyloplast series 2708AG inline drain fitting with 8" diameter solid ductile iron grate model number 0899CGC.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Sub-Soil Drainage Piping shall be the following:
 1. High density polyethylene perforated pipe with Bell and spigot fittings or plain ends.
- B. Sub-Soil Drainage Piping up to clean outs shall be the following:
 1. High density polyethylene solid wall pipe with split or snap coupling fittings.

3.2 PIPING INSTALLATION

- A. The Sub-Soil drainage piping shall follow the bottom of the grade beam with the flow line the same elevation as the bottom of the grade beam. In this case the piping shall be laid level with no slope. There shall be no low points in the system such that drainage is trapped.
- B. Make changes in direction for sub-soil drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees.

- C. Install cleanouts at grade and extend to where sub-soil drains connect to sump pump. Polyethylene piping shall be extended up to grade at each turn of 90 degrees and at each run of piping of 100 feet or multiples of 100 feet. At each point where the piping is extended up to grade a cleanout will be installed to be able to flush the piping from that point to the point where the piping enters into the sump pump. The covers on the cleanouts shall be labeled for "sub-soil" drainage.
- D. Install cleanouts in the direction of flow.
- E. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- F. Wrap perforated piping with geotextile fabric as indicated on the drawings.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results Plumbing."
- B. Assemble piping in accordance with ASTM D-2321, and manufacturers written instructions.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect sub-soil drainage piping to sump pump.

3.5 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.6 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 221423

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following storm drainage piping specialties:

- ~~1. Backwater valves.~~
2. Cleanouts.
3. Trench drains.
4. Through-penetration firestop assemblies.
5. Roof drains.
6. Miscellaneous storm drainage piping specialties.

- B. Related Sections include the following:

1. Division 07 Section "Sheet Metal Flashing and Trim"

1.2 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.5 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

~~2.1 BACKWATER VALVES~~

- ~~A. Manufacturers:~~

- ~~1. Josam Company; Josam Div.~~
- ~~2. MIFAB, Inc.~~

3. ~~Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.~~
4. ~~Tyler Pipe; Wade Div.~~
5. ~~Watts Drainage Products Inc.~~
6. ~~Zurn Plumbing Products Group.~~
7. ~~NDS Inc.~~
8. ~~Oatey.~~
9. ~~Sioux Chief Manufacturing Company, Inc.~~

~~B. Horizontal, Cast Iron Backwater Valves:~~

1. ~~Standard: ASME A112.14.1.~~
2. ~~Size: Same as connected piping.~~
3. ~~Body: Cast iron.~~
4. ~~Cover: Cast iron with bolted or threaded access check valve.~~
5. ~~End Connections: Hub and spigot.~~
6. ~~Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.~~
7. ~~Extension: ASTM A 74, Service class; full-size, cast iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.~~

~~C. Drain-Outlet Backwater Valves:~~

1. ~~Size: Same as area drain outlet.~~
2. ~~Body: Cast iron or bronze made for vertical installation in bottom outlet of area drain.~~
3. ~~Check Valve: Removable ball float.~~
4. ~~Inlet: Threaded.~~
5. ~~Outlet: Threaded or spigot.~~

~~D. Horizontal, Plastic Backwater Valves:~~

1. ~~Size: Same as connected piping.~~
2. ~~Body: PVC.~~
3. ~~Cover: Same material as body with threaded access to check valve.~~
4. ~~Check Valve: Removable swing check.~~
5. ~~End Connections: Socket type.~~

2.2 CLEANOUTS

A. Cleanouts

1. Basis-of-Design Product: Subject to compliance with requirements, Refer to table for area and provide the product indicated or a comparable product by one of the following:
 - 1) Linoleum Floors: J.R. Smith Series 4140 - round top with insert
 - 2) Carpeted Floors: J.R. Smith Series 4240-Y - round with carpet marker
 - 3) Exterior: J. R. Smith 4240 - round with cast iron cover
 - 4) Wall: J.R. Smith Series 4710
 - 5) Quarry Floor: J.R. Smith Series 4053-PB - square bronze top
 - 6) Ceramic Floor: J.R. Smith Series 4053-NB - square nickel bronze top
 - 7) Concrete Floors: J. R. Smith Series 4100 – round galvanized cast iron top.
 - 8) Truck/Loading Dock Areas: J. R. Smith Series 4231 – ductile iron top.
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.

- c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Body Material: cast-iron as required to match connected piping.
 - 4. Closure: Countersunk or raised-head, brass plug.
 - 5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

2.3 TRENCH DRAINS

A. Trench Drains:

- 1. Manufacturers:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.3 for trench drains.
- 3. Material: Ductile or gray iron.
- 4. REFER TO FIXTURE SCHEDULE FOR FIXTURE PARAMETERS.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

- 1. Available Manufacturers:
 - a. ProSet Systems Inc.
- 2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
- 3. Size: Same as connected pipe.
- 4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.5 ROOF DRAINS

A. Metal Roof Drains:

- 1. Manufacturers:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Portals Plus, Inc.
 - d. Prier Products, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.

- g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group.
- 2. Standard: ASME A112.21.2M.
 - 3. REFER TO FIXTURE SCHEDULE FOR UNIT DESCRIPTION.

2.6 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:

- 1. Standard: ASME A112.21.2M.
- 2. Body: Cast iron with bronze sleeve, packing, and gland.
- 3. End Connections: Matching connected piping.
- 4. Size: Same as connected piping.

B. Downspout Boots:

- 1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
- 2. Size: Inlet size to match downspout.
- 3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
- 4. Size: Same as or larger than connected downspout.

C. Downspout Nozzles:

- 1. REFER TO FIXTURE SCHEDULE.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 100 feet.
 - 4. Locate at base of each vertical stack.
 - 5. Do not locate cleanouts above finished ceilings.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor. Do not install in public areas.
- D. For cleanouts located in concealed locations, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface.

- F. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
 - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- H. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- ~~I. Install manufactured, gray iron downspout boots at grade with top [6 inches] [12 inches] [18 inches] <Insert dimension> above grade. Secure to building wall. Provide splash block.~~
- ~~J. Install cast iron soil pipe downspout boots at grade with top of hub [6 inches] [12 inches] [18 inches] <Insert dimension> above grade. Provide splash block.~~
- K. Install downspout nozzles at exposed bottom of conductors where they spill onto grade. Provide splash block.
- L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 PROTECTION

- A. Protect drains during construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 223100
DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes commercial water softeners.
 - 1. Chemicals.
 - 2. Water testing kits.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Water Softeners. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Water testing kits.
- B. Shop Drawings: For water softeners. Include plans, elevations, sections, details, and connections to piping systems.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Certificates: Signed by manufacturers certifying that water softeners comply with requirements.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

- H. Maintenance service agreement.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASME Compliance:
 - 1. Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, where indicated.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of mineral and brine tanks.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - d. Attrition loss of resin exceeding 3 percent per year.
 - e. Mineral washed out of system during service run or backwashing period.
 - f. Effluent turbidity greater and color darker than incoming water.
 - g. Fouling of underdrain system, gravel, and resin, with turbidity or by dirt, rust, or scale from softener equipment or soft water, while operating according to manufacturer's written operating instructions.
 - 2. Commercial Water Softener, Warranty Period: From date of Substantial Completion.
 - a. Mineral Tanks:
 - 1) Steel Tanks: 1 year.
 - 2) Fiberglass Tanks: 5 years.
 - b. Brine Tanks: 5 years.
 - c. Controls: 1 year.
 - d. Underdrain Systems: 5 years.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Salt for Brine Tanks: Furnish same form as and at least four two times original load, but not less than ~~200-lb~~ 1000 lb.
 2. Deliver salt on pallets in 50-lb bags
 3. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
- a. Marlo, Inc.
 - b. Culligan International Company
 - c. Ecodyne Water Treatment
 - d. Hungerford & Terry, Inc.
 - e. Unity
 - f. Lakeside Water Treatment
 - g. Watt's Water Conditioning

2.2 COMMERCIAL WATER SOFTENERS

- A. Description: Factory-assembled, pressure-type water softener.
1. Comply with NSF 61, "Drinking Water System Components--Health Effects."
 2. Configuration: ~~[Single unit with one mineral tank]~~ Twin unit with two mineral tanks ~~[Triple unit with three mineral tanks]~~ and one brine tank, factory mounted on skids.
 3. Mineral Tanks: FRP, pressure-vessel quality.
 - a. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels."
 - b. Pressure Rating: ~~400 psig~~ 125 psig minimum.
 - c. Wetted Components: Suitable for water temperatures from ~~40 to at least 100 deg F~~ ~~40 to at least 120 deg F~~ ~~40 to at least 150 deg F~~.
 - d. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
 - e. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
 - f. Upper Distribution System: Single, point type, fabricated from non-metallic pipe and fittings.

- g. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers; arranged for even flow distribution through resin bed.
 - h. Liner: PE, ABS, or other material suitable for potable water.
4. Mineral Tanks: ~~Steel~~Stainless steel, electric welded; pressure-vessel quality.
- a. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
 - b. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."
 - c. Pressure Rating: ~~100 psig~~ 125 psig ~~150 psig~~ minimum.
 - d. Wetted Components: Suitable for water temperatures from ~~40 to at least 100 deg F~~ 40 to at least 120 deg F ~~40 to at least 150 deg F~~.
 - e. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
 - f. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
 - g. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.
 - h. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
 - i. Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.
 - j. Upper Distribution System: Single, point type, fabricated from non-metallic pipe and fittings.
 - k. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
 - l. Liner: PE, ABS, or other material suitable for potable water.
5. Controls: Fully automatic; factory mounted on unit and factory wired.
- a. PLC programmable logic controller in a NEMA-4X enclosure featuring digital display flow rate, peak flow rate, batch volume remaining, totalizer, and a regeneration cycle timer/indicator. A regeneration required visual alarm is provided and is located on the controller front panel display. PLC controller is provided with extra I/O cards for future expansion. Provided with Modbus for connection to BMS. Controller is programmed to operate the system in either an alternating/additive flow (based on flow requirement) mode.
 - b. Adjustable duration of various regeneration steps.
 - c. Push-button start and complete manual operation.
 - d. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
 - e. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
 - f. Pointer on pilot-control valve shall indicate cycle of operation.
 - g. Means of manual operation of pilot-control valve if power fails.
 - h. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
 - 1) Slow opening and closing, nonslam operation.
 - 2) Diaphragm guiding on full perimeter from fully open to fully closed.
 - 3) Isolated dissimilar metals within valve.

- 4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
 - 5) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
 - 6) Sampling cocks for soft water.
 - 7) Special tools are not required for service.
- i. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.
- 1) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons. Design so signal will continue until reset.
 - 2) Demand-Initiated Control: Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Design so head automatically resets to preset total in gallons for next service run.
 - 3) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to initiate regeneration at preset total in gallons. Design so heads automatically reset to preset total in gallons for next service run. Include electrical lockout to prevent simultaneous regeneration of both tanks.
 - 4) Demand-Initiated Control: Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.
 - 5) Demand-Initiated Control: Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to automatically regenerate at preset total in gallons. Design so heads automatically reset to preset total in gallons for next service run. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.
 - 6) Demand-Initiated Control: Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tanks. Set to repeat with other tanks. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.
6. Brine Tank: Combination measuring and wet-salt storing system.
- a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
 - b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
 - c. Size: Large enough for at least four regenerations at full salting.
7. Factory-Installed Accessories:
- a. Piping, valves, tubing, and drains.
 - b. Sampling cocks.
 - c. Main-operating-valve position indicators.
 - d. Water meters.

B. Capacity and Characteristics:

1. Service: Cold Hot water.
2. Water Analysis:
 - a. Hardness: <Insert grains/gal. or ppm.>
 - b. Iron: <Insert ppm.>
 - c. Dissolved Solids: <Insert ppm.>
 - d. Concentration: <Insert pH.>
 - e. Inlet Water Pressure: <Insert psig.>
 - f. Water Temperature: <Insert deg F.>
3. Refer to schedule on drawings

2.3 CHEMICALS

- A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
1. ~~Exchange Capacity: <Insert capacity> of calcium carbonate of resin when regenerated with 15 lb of salt.~~
- B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

2.4 WATER TESTING SETS

- A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.5 SOURCE QUALITY CONTROL

- A. Hydrostatically test mineral tanks before shipment to minimum of one and one-half times pressure rating.
- B. Prepare test reports.

PART 3 - EXECUTION

3.1 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results for Plumbing."
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 WATER SOFTENER INSTALLATION

- A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- D. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."
- D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
 - 1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
 - 3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
- E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
 - 1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
 - 2. Exception: Water softeners in hot-water service.
- F. Install valved bypass water piping around water softeners.
 - 1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
 - 3. Water piping is specified in Division 22 Section "Domestic Water Piping."
- G. Install drains as indirect wastes to spill into open drains or over floor drains.

- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
- B. Add water to brine tanks and fill with salt.
- C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
 - 1. ASTM D 859, "Test Method for Silica in Water."
 - 2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
 - 3. ASTM D 1068, "Test Methods for Iron in Water."
 - 4. ASTM D 1126, "Test Method for Hardness in Water."
 - 5. ASTM D 1129, "Terminology Relating to Water."
 - 6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners. Refer to Division 01 "Demonstration and Training" Section

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SECTION 223300

ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following electric water heaters:

1. Electric booster heaters.
2. Storage electric water heaters.
3. Expansion tanks.
4. Water heater accessories.

1.2 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Diagram power, signal, and control wiring.
2. Short-circuit current rating of equipment assembly.

C. Product Certificates: For each type of electric water heater, signed by product manufacturer.

D. **Manufacturer Seismic Qualification Certification:** Refer to Architect for seismic criteria. Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of gravity and locate and describe mounting and anchorage provisions.
3. **Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.**

E. Source quality-control test reports.

F. Field quality-control test reports.

- G. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - d. Consider "rusty water" a failure.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Electric Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: One year.
 - b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 ELECTRIC WATER HEATERS

- A. Commercial Electric Booster Heaters: Comply with UL 1453 requirements for booster-type water heaters.

1. Manufacturers:

- a. Bradford White Corporation.
- b. Lochinvar Corporation.
- c. Ruud Water Heater Div.; Rheem Manufacturing Company.
- d. Smith, A. O. Water Products Company.

2. Storage-Tank Construction: [**Corrosion-resistant metal**] [**Corrosion-resistant metal or steel**].

- a. Fittings: ASME B1.20.1 pipe thread.
- b. Pressure Rating: 150 psig.
- c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into Fittings.

3. Factory-Installed Storage-Tank Appurtenances:

- a. Anode Rod (if needed): Replaceable magnesium.
- b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
- c. Insulation: Comply with ASHRAE/IESNA 90.1.
- d. Heating Elements: Electric, screw-in or bolt-on immersion type.
 - 1) Option: Booster heaters with 9 kW or less total may have 2 or 3 elements.
 - 2) Staging: Input not exceeding [**36 kW**] <Insert kW> per step.
- e. Temperature Control: Adjustable thermostat, to setting of at least 180 deg F.
- f. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
- g. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
- h. Gages: Combination temperature and pressure type or separate thermometer and pressure gage.

4. Special Requirements: NSF 5 construction.

5. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

- B. Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Manufacturers:

- a. Patterson-Kelly
- b. Bradford White Corporation.
- c. Lochinvar Corporation.
- d. PVI Industries, LLC.

- e. Ruud Water Heater Div.; Rheem Manufacturing Company.
 - f. Smith, A. O. Water Products Company.
 - g. State Industries, Inc.
2. Storage-Tank Construction: ASME-code, steel vertical or horizontal arrangement.
- a. Fittings: Factory fabricated of materials compatible with tank and piping connections.
 - 1) NPS 3 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: **[150 psig] <Insert psig (kPa)>**.
 - c. Interior Finish: Apply interior finish after tank fabrication. Tank lining **[Plastic] [Glass] [Nickel plate]**. Comply with NSF 61 barrier materials for potable-water tank linings,
3. Factory-Installed Storage-Tank Appurtenances:
- a. Anode Rod (if needed): Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type.
 - 1) Staging: Input not exceeding **[36 kW] <Insert kW>** per step.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
4. Facility Management System Interface: Normally closed dry contacts for enabling and disabling water heater.
5. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.2 EXPANSION TANKS

- A. Description: Steel ASME pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
1. Manufacturers:
- a. AMTROL Inc.
 - b. Taco, Inc.
 - c. Watts Regulator Co.
 - d. ELBI

2. Construction:

- a. Fittings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
- b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.3 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- D. Piping-Type Heat Traps for non-circulated systems: Field-fabricated piping arrangement according to International Plumbing Code.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
 - 2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

- C. Install seismic restraints for water heaters. Anchor to substrate.
- D. Install combination temperature and pressure relief valves in top portion of water heaters. Use relief valves with sensing elements that extend into tanks. Extend water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains.
- F. Install thermometer on inlet and outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Install pressure gage(s) on inlet and outlet of commercial electric water- heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- H. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- I. Fill water heaters with water.
- J. Charge expansion tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 223500

DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following heat exchangers:

1. ~~Semi-Instantaneous heat exchangers.~~
2. ~~Circulating, storage heat exchangers.~~
3. ~~Expansion tanks.~~
4. ~~Heat-exchanger accessories.~~

1.2 SUBMITTALS

- A. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: For each type of ~~[Semi-instantaneous]~~ **[circulating]** heat exchanger, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of heat exchangers through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of heat exchangers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.

~~1. Failures include, but are not limited to, the following:~~

- a. Structural failures including heat exchanger, storage tank, and supports.
- b. Faulty operation of controls.
- c. Deterioration of metals, metal finishes, and other materials beyond normal use.
- d. Consider "rusty water" a failure

~~2. Warranty Period(s): From date of Substantial Completion:~~

- a. Instantaneous Heat Exchangers:
 - 1) Tube Coil and Shell: Five years.
 - 2) Controls and Other Components: Five years.
- b. Circulating, Storage Heat Exchangers:
 - 1) Storage Tank: Five years.
 - 2) Tube Coil: Five years.
 - 3) Controls and Other Components: Five years.
- c. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 SEMI-INSTANTANEOUS HEAT EXCHANGERS

- A. Semi-Instantaneous Heat Exchangers:

~~1. Manufacturers:~~

- a. Aerco
- b. Patterson-Kelley.
- c. PVI Industries, LLC.

~~2. Description: Packaged assembly of heat exchanger coil, controls, and specialties for heating domestic water in shell with heating hot water [steam] in coil.~~

~~3. Construction: ASME code, negligible capacity, carbon steel or copper alloy shell with 150-psig minimum working pressure rating.~~

- a. Configuration: Horizontal **Vertical**.
- b. Shell Fittings: Factory fabricated of materials compatible with water heater shell. Attach fittings to shell before testing and labeling.

- 1) NPS 3 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
- c. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature.
- d. Heat-Exchanger Coil: Copper, **double** single-wall, for heating fluid.
- 1) Tube Pressure Rating: Equal to or greater than heating-fluid supply pressure.
4. ~~Temperature Control: Adjustable thermostat that operates water control valve [steam-control valve] and that is capable of maintaining outlet water temperature within ± 5 deg F of setting.~~
 5. ~~Safety Control: Automatic, high-temperature-limit cutoff device or system.~~
 6. ~~Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working pressure rating of heat exchanger. Select one relief valve with sensing element that extends into shell.~~
 7. ~~Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping.~~
 8. ~~Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping.~~
 9. ~~Stand: Factory fabricated for floor mounting.~~
 10. ~~Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS~~

2.2 CIRCULATING, STORAGE HEAT EXCHANGERS

A. Circulating, Storage Heat Exchangers:

1. ~~Manufacturers:~~
 - a. Patterson-Kelley.
 - b. PVI Industries, LLC.
 - c. Smith, A. O. Water Products Company.
2. ~~Description: Packaged, large-capacity, hot-water storage tank with heat-exchanger coil, circulator, controls, and specialties for heating domestic water with heating hot water [steam] in coil.~~
3. ~~Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.~~
4. ~~Flow Pattern: Reverse-flow arrangement, with water from storage tank drawn across heat-exchanger coil and returned to bottom of tank. Include hot-water outlet and temperature sensor located in or at coil shell.~~
5. ~~Storage Tank Construction: ASME-code [steel] <Insert material> with [125-psig] [150-psig] <Insert psig (kPa)> working-pressure rating. Include nozzle and head for heat-exchanger tube coil.~~
 - a. ~~Configuration: [Horizontal] [Vertical].~~
 - b. ~~Manhole: 11 by 15 inches in 36" diameter and greater storage tank shell.~~
 - c. ~~Fittings: Factory fabricated of materials compatible with tank. Attach fittings to tank before testing and labeling.~~
- 1) ~~NPS 3 and Smaller: Threaded ends according to ASME B1.20.1.~~

- 2) ~~NPS 4 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.~~
- d. ~~Lining: [Plastic] [Glass] [Nickel plate] [Copper] complying with NSF 61 barrier materials for potable-water tank linings. Apply interior finish after tank fabrication.~~
- e. ~~Anode Rods (if needed): Factory installed, magnesium.~~
- f. ~~Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.~~
6. ~~Heat-Exchanger Coil: [NPS 3/4] [NPS 1-1/4] <Insert size> diameter, [vented, double-wall,] copper or copper-alloy, U tubes with tube sheet and supporting baffles.~~
 - a. ~~Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.~~
7. ~~Temperature Control: Adjustable temperature aquastat, mounted in storage tank shell head, unless otherwise indicated.~~
8. ~~Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.~~
9. ~~Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.~~
10. ~~Gages: Factory-mounted thermometer and pressure gage.~~
11. ~~Circulating Pump: UL 778, all-bronze, centrifugal, overhung impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, [125-psig] <Insert psig (kPa)> minimum working-pressure rating, and 225 deg F continuous-water-temperature rating.~~
 - a. ~~Pump Control: Sensor for operating pump and control valve.~~
12. ~~Support: Factory mounted on skids.~~
13. ~~Facility Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.~~
14. ~~Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS~~

2.3 EXPANSION TANKS

- A. Description: Steel, ASME pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Taco, Inc.
 - c. Watts Regulator Co.
 - d. ELBI
 2. Construction:
 - a. Fittings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 3. Capacity and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 HEAT-EXCHANGER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valves with sensing element that extends into heat-exchanger storage tank.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect heat-exchanger storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test heat-exchanger storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

- A. Install heat exchangers on concrete bases.
 - 1. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Anchor heat exchangers to substrate.
- D. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install combination temperature and pressure relief valves in water piping for heat exchangers without storage. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for heat exchangers that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- G. Install thermometer on each heat-exchanger domestic-water inlet and outlet piping, and install thermometer on each heat-exchanger heating-fluid inlet and outlet piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

- H. Install pressure gages on heat-exchanger heating-fluid piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- I. Fill heat exchangers with water.
- J. Charge compression tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace heat exchangers that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

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SECTION 224000
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
1. Faucets for lavatories ~~bathtubs bathtub/showers~~ showers and sinks.
 2. Flushometers.
 3. Toilet seats.
 4. Protective shielding guards.
 5. P-traps, Supplies and strainers.
 6. Fixture supports.
 7. Interceptors.
 8. Shower receptors.
 9. Dishwasher air-gap fittings.
 10. Disposers.
 11. ~~Hot water dispensers.~~
 12. Water closets.
 13. Urinals.
 14. Lavatories.
 15. Sinks.
 16. ~~Shampoo bowls.~~
 17. ~~Wash fountains.~~
 18. ~~Bathtubs.~~
 19. Showers.
 20. ~~[Whirlpool bathtubs.]~~
 21. Service sinks.
 22. Service basins.
 23. ~~Laundry trays.~~
- B. Related Sections include the following:
1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
 2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
 3. Division 22 Section "Healthcare Plumbing Fixtures."
 4. Division 22 Section "Emergency Plumbing Fixtures."
 5. Division 22 Section "Drinking Fountains and Water Coolers."
 6. Division 31 Section "Facility Water Distribution Piping" for exterior plumbing fixtures and hydrants.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act" ; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 2. Plastic Bathtubs: ANSI Z124.1.
 3. Plastic Lavatories: ANSI Z124.3.
 4. Plastic Laundry Trays: ANSI Z124.6.
 5. Plastic Mop-Service Basins: ANSI Z124.6.
 6. Plastic Shower Enclosures: ANSI Z124.2.
 7. Plastic Sinks: ANSI Z124.6.
 8. Plastic Urinal Fixtures: ANSI Z124.9.
 9. Plastic Whirlpool Bathtubs: ANSI Z124.1 and ASME A112.19.7M.
 10. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 11. Slip-Resistant Bathing Surfaces: ASTM F 462.
 12. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 13. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 14. Stainless-Steel Residential Sinks: ASME A112.19.3.
 15. Vitreous-China Fixtures: ASME A112.19.2M.
 16. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 17. Water-Closet, Flushometer Tank Trim: ASSE 1037.
 18. Whirlpool Bathtub Fittings: ASME A112.19.8M.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 4. Faucets: ASME A112.18.1.
 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 8. NSF Potable-Water Materials: NSF 61.
 9. Pipe Threads: ASME B1.20.1.
 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 11. Supply Fittings: ASME A112.18.1.
 12. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for bathtub/shower faucets:
1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
 4. Faucets: ASME A112.18.1.
 5. Hand-Held Showers: ASSE 1014.
 6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 7. Hose-Coupling Threads: ASME B1.20.7.
 8. Manual-Control Antiscald Faucets: ASTM F 444.
 9. Pipe Threads: ASME B1.20.1.
 10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

- J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 4. Manual-Operation Flushometers: ASSE 1037.
 5. Plastic Tubular Fittings: ASTM F 409.
 6. Brass Waste Fittings: ASME A112.18.2.
 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Dishwasher Air-Gap Fittings: ASSE 1021.
 3. Flexible Water Connectors: ASME A112.18.6.
 4. Floor Drains: ASME A112.6.3.
 5. Grab Bars: ASTM F 446.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Hot-Water Dispensers: ASSE 1023 and UL 499.
 8. Off-Floor Fixture Supports: ASME A112.6.1M.
 9. Pipe Threads: ASME B1.20.1.
 10. Plastic Shower Receptors: ANSI Z124.2.
 11. Plastic Toilet Seats: ANSI Z124.5.
 12. Supply and Drain Protective Shielding Guards: ICC A117.1.
 13. Whirlpool Bathtub Equipment: UL 1795.

1.5 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
 4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
 5. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
 6. Toilet Seats: Equal to 5 percent of amount of each type installed.
 7. Dry Urinal Trap-Seal Cartridges: 10 of each type installed.

8. Dry Urinal Trap-Seal Liquid: Equal to 1 gal for each urinal installed.

PART 2 - PRODUCTS

2.1 LAVATORY AND SINK FAUCETS

- A. Lavatory and Sink Faucets:
1. Manufacturers:
 - a. American Standard Companies, Inc.
 - b. Chicago Faucets.
 - c. Delta Faucet Company.
 - d. Eljer.
 - e. Elkay Manufacturing Co.
 - f. Just Manufacturing Company.
 - g. Kohler Co.
 - h. Moen, Inc.
 - i. Speakman Company.
 - j. T & S Brass and Bronze Works, Inc.
 - k. Zurn Plumbing Products Group.

~~2.2 BATHTUB/SHOWER FAUCETS~~

- ~~A. Bathtub/Shower Faucets:~~
- ~~1. Manufacturers:~~
 - ~~a. American Standard Companies, Inc.~~
 - ~~b. Chicago Faucets.~~
 - ~~c. Delta Faucet Company.~~
 - ~~d. Eljer.~~
 - ~~e. Kohler Co.~~
 - ~~f. Moen, Inc.~~
 - ~~g. Speakman Company.~~
 - ~~h. Symmons Industries, Inc.~~
 - ~~i. T & S Brass and Bronze Works, Inc.~~
 - ~~j. Zurn Plumbing Products Group.~~

2.3 FLUSHOMETERS

- A. Flushometers:
1. Manufacturers:
 - a. Coyne & Delany Co.
 - b. Sloan Valve Company.
 - c. Zurn Plumbing Products Group.

2.4 TOILET SEATS

- A. Toilet Seats:
1. Manufacturers:

- a. American Standard Companies, Inc.
- b. Bemis Manufacturing Company.
- c. Centoco Manufacturing Corp.
- d. Church Seats.
- e. Eljer.
- f. Kohler Co.
- g. Olsonite Corp.
- h. Sperzel.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

- 1. Manufacturers:
 - a. Engineered Brass Co.
 - b. McGuire Manufacturing Co., Inc.
 - c. TRUEBRO, Inc.
 - d. Zurn Plumbing Products Group.
- 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements and ASTM E-84.

2.6 P-TRAPS, SUPPLIES, STRAINERS

A. Manufacturers:

- 1. McGuire Manufacturing Co., Inc.
- 2. Elkay Manufacturing Co.
- 3. American Standard Companies, Inc.
- 4. Kohler Co.
- 5. Engineered Brass Co.
- 6. Zurn Plumbing Products Group.

2.7 FIXTURE SUPPORTS

A. Manufacturers:

- 1. Josam Company.
- 2. MIFAB Manufacturing Inc.
- 3. Smith, Jay R. Mfg. Co.
- 4. Tyler Pipe; Wade Div.
- 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
- 6. Zurn Plumbing Products Group.

2.8 INTERCEPTORS

A. Manufacturers:

- 1. Josam Company.
- 2. MIFAB Manufacturing Inc.
- 3. Smith, Jay R. Mfg. Co.
- 4. Tyler Pipe; Wade Div.
- 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
- 6. Zurn Plumbing Products Group.

B. ~~Hair Interceptors:~~

- ~~1. Description: Manufactured unit with removable screen or strainer and removable cover; designed to trap and retain hair.~~

~~a. Material: stainless steel body.~~

~~b. Pipe Connections: NPS 1-1/2.~~

C. Sediment Interceptors:

1. Description: Manufactured unit with removable screens or strainer and removable cover; designed to trap and retain waste material.

a. Material: carbon-steel body with acid-resistant lining and coating.

b. Pipe Connections: NPS 1-1/2 NPS 2.

2.9 SHOWER RECEPTORS

A. Shower Receptors:

1. Manufacturers:
- a. Crane Plumbing, L.L.C./Fiat Products.
 - b. Florestone Products Co., Inc.
 - c. LASCO Bathware.
 - d. Acorn Engineering Company.
 - e. Precast Terrazzo Enterprises, Inc.
 - f. Stern-Williams Co., Inc.
 - g. Bradley Corporation.
 - h. Formica Corporation.
 - i. Jacuzzi, Inc.
 - j. Swan Corporation (The).

2.10 DISHWASHER AIR-GAP FITTINGS

A. Dishwasher Air-Gap Fittings:

1. Manufacturers:
- a. Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.
 - b. Dearborn Brass; a div. of Moen, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Watts Brass & Tubular; a division of Watts Regulator Co.
2. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at a temperature of at least 140 deg F. Include 5/8-inch-ID inlet and 7/8-inch-ID outlet hose connections.
3. Hoses: Rubber and suitable for temperature of at least 140 deg F.
- a. Inlet/Outlet Hose: 5/8-inch ID and 48 inches long.

2.11 DISPOSERS

A. Disposers:

1. Manufacturers:

- a. In-Sink-Erator; a div. of Emerson Electric Co.
 - b. KitchenAid.
- 2. Description: Batch-feed household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

~~2.12~~ ~~HOT WATER DISPENSERS~~

~~A. Hot Water Dispensers:~~

~~1. Manufacturers:~~

- ~~a. In-Sink-Erator; a div. of Emerson Electric Co.~~
- ~~b. Just Manufacturing Company.~~

2.13 WATER CLOSETS

A. Water Closets:

1. Manufacturers:

- a. American Standard Companies, Inc.
- b. Zurn Plumbing Products Group.
- c. Eljer.
- d. Kohler Co.

2.14 URINALS

A. Urinals:

1. Manufacturers:

- a. American Standard Companies, Inc.
- b. Zurn Plumbing Products Group.
- c. Eljer.
- d. Kohler Co.

2.15 LAVATORIES

A. Lavatories:

1. Manufacturers:

- a. American Standard Companies, Inc.
- b. Eljer.
- c. Kohler Co.
- d. Zurn Plumbing Products Group.

2.16 SINKS

A. Sinks:

1. Manufacturers:

- a. Elkay Manufacturing Co.
- b. Just Manufacturing Company.
- c. Metal Masters Foodservice Equipment Co., Inc.

2.17 ~~SHAMPOO BOWLS~~

A. ~~Shampoo Bowls:~~

1. ~~Manufacturers:~~

- a. ~~Belvedere USA Corporation; a Subsidiary of the Wella Corporation, North America.~~
- b. ~~Marble Products USA; a division of Takara Belmont.~~

2.18 ~~WASH FOUNTAINS~~

A. ~~Wash Fountains:~~

1. ~~Manufacturers:~~

- a. ~~Acorn Engineering Company.~~
- b. ~~Bradley Corporation.~~
- c. ~~Intersan Manufacturing Company.~~

2.19 ~~BATHTUBS~~

A. ~~Bathtubs:~~

1. ~~Manufacturers:~~

- a. ~~Eljer.~~
- b. ~~Kohler Co.~~
- c. ~~American Standard Companies, Inc.~~

2.20 SHOWERS

A. Showers:

1. Manufacturers:

- a. Aqua Glass Corporation.
- b. Florestone Products Co., Inc.
- c. LASCO Bathware.
- d. Swan Corporation (The).
- e. Aqua Bath Company, Inc.
- f. Kohler Co.

2.21 ~~[WHIRLPOOL BATHTUBS]~~

A. ~~[Whirlpool Bathtubs, <Insert drawing designation>:~~

1. ~~Manufacturers:~~

- a. ~~Eljer.~~
- b. ~~Kohler Co.~~
- c. ~~<Insert manufacturer's name.>~~

- d. ~~Aker Plastics Co., Inc.~~
 - e. ~~Best Bath Systems; a div. of Fiberglass Systems, Inc.~~
 - f. ~~Clarion Bathware.~~
 - g. ~~Praxis Industries, Inc.; Aquarius Products.~~
 - h. ~~Sterling Plumbing Group, Inc.~~
 - i. ~~<Insert manufacturer's name.>~~
 - j. ~~Aker Plastics Co., Inc.~~
 - k. ~~American Standard Companies, Inc.~~
 - l. ~~American Whirlpool Products Corp.~~
 - m. ~~Aqua Glass Corporation.~~
 - n. ~~Aquatic Industries, Inc.~~
 - o. ~~Benjamin Manufacturing Co., Inc.~~
 - p. ~~Clarion Bathware.~~
 - q. ~~Clarke Products, Inc.~~
 - r. ~~Crane Plumbing, L.L.C./Fiat Products.~~
 - s. ~~Eljer.~~
 - t. ~~Florestone Products Co., Inc.~~
 - u. ~~Jacuzzi, Inc.~~
 - v. ~~Jason International, Inc.~~
 - w. ~~Kohler Co.~~
 - x. ~~LASCO Bathware.~~
 - y. ~~Lyons Industries, Inc.~~
 - z. ~~Mansfield Plumbing Products, Inc.; Acrylic Operations.~~
 - aa. ~~Praxis Industries, Inc.; Aquarius Products.~~
 - bb. ~~Royal Baths Manufacturing Co.~~
 - cc. ~~Southland Spa & Sauna Inc.~~
 - dd. ~~<Insert manufacturer's name.>~~
 - ee. ~~American Standard Companies, Inc.~~
 - ff. ~~Mansfield Plumbing Products, Inc.~~
 - gg. ~~<Insert manufacturer's name.>~~
2. ~~Description: Packaged, [enameled, cast iron] [FRP] [PMMA] [porcelain-enameled, formed steel] hydromassage bathtub with air entrained water jet nozzles and water circulation.~~
- a. ~~Seating Capacity: [One] [Two] <Insert number> person(s).~~
 - b. ~~Bathing Surface: Slip resistant.~~
 - c. ~~Size: [60 by 30 inches] [66 by 30 inches] [60 by 42 inches] <Insert dimensions>.~~
 - d. ~~Nominal Water Capacity: <Insert gal.>~~
 - e. ~~Base for Drop-in Unit: <Insert description> with access panel.~~
 - f. ~~Apron: Matching unit, covering exposed front and sides, and with access panel.~~
 - g. ~~Color: [White] <Insert color>.~~
 - h. ~~Drain Location: [Left] [Right] end.~~
 - i. ~~Controls: For pump[, timer,] [and water heater].~~
 - j. ~~Faucet: Fixture manufacturer's [individual valves] [mixing valve] with over-rim tub filler.~~
 - k. ~~Supplies: NPS 1/2 copper tubing with ball, gate, or globe valves.~~
 - l. ~~Drain: NPS 1-1/2; chrome-plated exposed parts; brass pop-up waste and overflow.~~
 - m. ~~Drain Piping: NPS 1-1/2 cast-brass P-trap and waste.~~
 - n. ~~Drain Piping: Schedule 40 [ABS] [or] [PVC], NPS 1-1/2 P-trap and waste.~~
 - o. ~~Water-Circulating System: Electric circulating pump and plastic piping.~~
 - p. ~~Water Heater: Electric, inline.~~
 - q. ~~Unit Electrical Characteristics:~~

- ~~1) Volts: [120] [240] [277] [480] <Insert number> V.~~
- ~~2) Phase(s): [One] [Three].~~
- ~~3) Hertz: [60] <Insert number> Hz.~~
- ~~4) Full-Load Amperes: <Insert value> A.~~
- ~~5) Minimum Circuit Ampacity: <Insert value> A.~~
- ~~6) Maximum Overcurrent Protection: <Insert value> A.]~~

2.22 SERVICE SINKS

- A. Service Sinks:
 1. Manufacturers:
 - a. American Standard Companies, Inc.
 - b. Eljer.
 - c. Kohler Co.
 - d. Zurn Plumbing Products Group.

2.23 SERVICE BASINS

- A. Service Basins:
 1. Manufacturers:
 - a. Acorn Engineering Company.
 - b. Florestone Products Co., Inc.
 - c. Stern-Williams Co., Inc.

~~2.24 LAUNDRY TRAYS~~

- ~~A. Laundry Trays:~~
 - ~~1. Manufacturers:~~
 - ~~a. Eljer.~~
 - ~~b. Swan Corporation (The).~~
 - ~~c. Zurn Plumbing Products Group; Light Commercial Operation.~~

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounting fixtures in and attached to casework.
- H. Install fixtures level and plumb according to roughing-in drawings.
- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- N. Install toilet seats on water closets.
- O. Install trap-seal liquid in dry urinals.
- P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

- S. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- T. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- U. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- V. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck. Connect inlet hose to dishwasher and outlet hose to disposer.
- W. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
- X. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- Y. Set shower receptors in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- Z. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 224500
EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following emergency plumbing fixtures:
 - 1. Emergency showers.
 - 2. Eyewash equipment.
 - 3. Eye/face wash equipment.
 - 4. Hand-held drench hoses.
 - 5. Combination units.
 - 6. Water-tempering equipment.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains.

1.2 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Moderately warm.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act" ; for plumbing fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers for Emergency Showers, Eyewash Equipment, Eye/Face-wash Equipment, Hand held Drench Hoses and Combination Units:
 - 1. Bradley Corporation.
 - 2. Guardian Equipment Co.
 - 3. Haws Corporation.
 - 4. Lab Safety Supply Inc.
 - 5. Speakman Company.

2.2 EMERGENCY SHOWERS

A. Emergency Showers:

- 1. Description: Plumbed, single-shower-head ~~[horizontal, wall-mounting]~~ **[vertical, ceiling-mounting]** ~~[freestanding]~~ emergency shower.
 - a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1-1/4 chrome-plated brass or stainless steel with flow regulator and stay open control valve.
 - c. Control Valve Actuator: Pull ~~[red]~~ **[chain]**.
 - d. Shower Head: 8-inch minimum diameter, ~~[chrome-plated brass or stainless steel]~~ **[plastic]**.

B. Emergency Showers, <DECONTAM SHOWER>:

1. Manufacturers:

- a. Guardian Equipment Co.
- b. Haws Corporation.
- c. Speakman Company.

- 2. Description: Plumbed, multiple-spray emergency shower with ~~[eight]~~ **[12]** small shower heads or nozzles.
 - a. Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1-1/4 minimum chrome-plated brass or stainless steel with flow regulator and stay open control valve.
 - c. Control Valve Actuator: Paddle.

2.3 EYEWASH EQUIPMENT

A. Eyewash Equipment:

1. Description: Plumbed, freestanding eyewash equipment.
 - a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Receptor: Chrome-plated brass or stainless-steel **Plastic** bowl.
 - e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

B. Eyewash Equipment:

1. Description: Plumbed, accessible, wall-mounting eyewash equipment with receptor and wall bracket.
 - a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Receptor: Chrome-plated brass or stainless-steel **Plastic** bowl.
 - e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

C. Eyewash Equipment:

1. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eyewash equipment.
 - a. Capacity: Deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.

2.4 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Equipment:

1. Description: Plumbed, accessible, wall-mounting eye/face wash equipment with receptor and wall bracket.
 - a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Receptor: Chrome-plated brass or stainless-steel **Plastic** bowl.
 - e. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

2.5 HAND HELD DRENCH HOSES

A. Hand-Held Drench Hoses, <Insert drawing designation>:

1. Description: Plumbed, wall-mounting, hand-held drench hose with wall bracket.

- a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
- b. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
- c. Control Valve Actuator: Paddle.
- d. Hose: Coiled, rubber or plastic.
- e. Spray Heads: [Single] [Twin].

B. Hand-Held Drench Hoses, <Insert drawing designation>:

1. Description: Plumbed, counter-mounting, hand-held drench hose.

- a. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
- b. Supply Fitting: NPS 1/2 brass with flow regulator.
- c. Hose: Rubber or plastic.
- d. Control Valve Actuator: Hand-held squeeze valve.
- e. Spray Heads: [Single] [Twin].

2.6 COMBINATION UNITS

A. Combination Units, <Insert drawing designation>:

1. Description: Plumbed, accessible, freestanding, with emergency shower and eye/face wash equipment.

a. Piping: Chrome-plated brass or stainless steel.

- 1) Unit Supply: NPS 1-1/2 from [top] [side].
- 2) Unit Drain: Outlet at side near bottom.
- 3) Shower Supply: NPS 1 with flow regulator and stay-open control valve.
- 4) Eye/Face Wash Supply: NPS 1/2 with flow regulator and stay-open control valve.

b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.

- 1) Control Valve Actuator: [Pull rod] [Pull chain].
- 2) Shower Head: 8-inch minimum diameter, [chrome-plated brass or stainless steel] [plastic].

c. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.

- 1) Control Valve Actuator: [Paddle] [Push bar].
- 2) Receptor: [Chrome-plated brass or stainless steel] [Plastic] bowl.

2.7 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment:

1. Manufacturers:

- a. Armstrong International, Inc.
- b. Bradley Corporation.
- c. Haws Corporation.
- d. Lawler Manufacturing Co., Inc.
- e. Leonard Valve Company.
- f. Powers, a Watts Industries Co.

2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

- a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 2 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2.8 SOURCE QUALITY CONTROL

A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

- E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- G. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
- H. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- J. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.
- C. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
- D. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.
- E. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary drainage piping.

3.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.5 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.

- B. Adjust equipment temperature settings.

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SECTION 224700

DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following water coolers and related components:
 - 1. Electric water coolers.
 - 2. Remote water coolers.
 - 3. Fixture supports.

1.2 DEFINITIONS

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Cast Polymer: Dense, cast-filled-polymer plastic.
- C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
- D. Fitting: Device that controls flow of water into or out of fixture.
- E. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
- F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
- G. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act" ; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERES

- A. Manufacturers:
 - 1. Halsey Taylor.
 - 2. Haws Corporation.
 - 3. Elkay

2.2 DRINKING FOUNTAINS

2.3 ELECTRIC WATER COOLERS

- A. Electric Water Coolers, REFER TO FIXTURE SCHEDULE:
 - 1. Description: Accessible, ARI 1010, wall-mounting electric water cooler for adult & child-mounting height.
 - a. Cabinet: Bilevel with two attached cabinets, all stainless steel.
 - b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 - c. Control: Push button.
 - d. Supply: NPS 3/8 with ball or angle stop valve.
 - e. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
 - f. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
 - 2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.

~~g. Support: Type I, II, water cooler carrier. Refer to "Fixture Supports" Article.~~

h. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.

~~2.4~~ **FIXTURE SUPPORTS**

~~A. Manufacturers:~~

- ~~1. Josam Co.~~
- ~~2. MIFAB Manufacturing, Inc.~~
- ~~3. Smith, Jay R. Mfg. Co.~~
- ~~4. Tyler Pipe; Wade Div.~~
- ~~5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.~~
- ~~6. Zurn Plumbing Products Group; Specification Drainage Operation.~~

~~B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.~~

- ~~1. Type I: Hanger-type carrier with two vertical uprights.~~
- ~~2. Type II: Bilevel, hanger-type carrier with three vertical uprights.~~
- ~~3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.~~

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Set remote water coolers above ceiling, unless otherwise indicated.
- D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball or angle stop valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

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SECTION 226113

MEDICAL COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig
2. Gas-powered-tool air piping and specialties, designated "instrument air," operating at 175 psig.

B. Related Sections include the following:

1. Division 12 Section "Healthcare Casework" for compressed-air outlets in medical casework.
2. Division 22 Section "General-Service Compressed-Air Piping" for general-service compressed-air piping.
3. Division 22 Section "Compressed-Air Equipment for Healthcare Facilities" for medical air compressors.
4. Division 22 Section "Compressed-Air Piping for Laboratory Facilities" for laboratory air piping.
5. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for hangers and supports.
6. Division 22 Section "Common Work Results for Plumbing" for Sleeves and Escutcheons.

1.2 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.**
- B. Low Voltage:** As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Medical Compressed-Air Piping Systems:** Include medical air and instrument air piping systems.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Medical / Instrument-air tubes and fittings.
2. Medical / Instrument -air valves and valve boxes.
3. Medical compressed-air outlets.
4. Medical compressed-air manifolds.
5. Medical compressed-air alarm system components.

B. Shop Drawings: Diagram power, signal, and control wiring.

- C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For Medical compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain Medical Air outlets of same type and from same manufacturer provided for in Division 22 Section "Gas Piping for Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Medical Compressed-Air Service(s): Do not interrupt medical compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of medical compressed-air service(s).
 - 2. Do not proceed with interruption of medical compressed-air service(s) without Owner's written permission.

1.6 COORDINATION

- A. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section "Vacuum Piping for Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
 - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
- B. Memory-Metal Couplings "SMART TAP": Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
 - 1. Manufacturers:
 - a. Smart Technology, Inc.
- C. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.
 - 1. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.
- ~~D. [PVC Pipe: ASTM D 1785, Schedule 40. (Protective conduit)~~
- ~~1. [PVC Fittings: ASTM D 2466, Schedule 40, socket type.]~~

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- ~~B. [Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.]~~

2.3 Manufacturers for All products listed below including valves, zone valve boxes, alarms and manifolds:

- a. Allied Healthcare Products, Inc.
- b. Amico Corporation.

- c. BeaconMedaes.

2.4 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Operation: Spring loaded.
 - 3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 7. Pressure Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple zone valves with pressure gages and in sizes required to permit manual operation of zone valves.
 - 1. Interior Finish: Factory-applied white enamel.
 - 2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
 - 3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.5 MEDICAL COMPRESSED-AIR OUTLETS

- A. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not

required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:

- a. Steel outlet box for recessed mounting and concealed piping.
- b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
- c. Double seals that will prevent air leakage.
- d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

- a. Brass housing with primary check valve.
- b. Double seals that will prevent air leakage.
- c. Cover plate with gas-service label.

3. Quick-Coupler gas outlets: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. D.I.S.S. gas outlets: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

- a. Medical Air outlets: CGA V-5, D.I.S.S. No. 1160.
- b. Instrument Air outlets: CGA V-5, D.I.S.S. No. 2080.

5. Cover Plates: One piece, ~~[stainless steel, with NAAMM AMP 503, No. 4 finish]~~ metal, with chrome-plated finish ~~[anodized aluminum]~~ and permanent, color-coded, identifying label matching corresponding service.

2.6 INSTRUMENT COMPRESSED-AIR PRESSURE CONTROL PANELS

A. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.

1. Minimum Working Pressure: 200 psig.
2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
3. Pressure Gages: 0- to 300-psig range.
4. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
5. Before final assembly, provide temporary dust shield and U-tube for testing.
6. Label cover plate "Air Pressure Control."

~~2.7 MEDICAL COMPRESSED-AIR MANIFOLDS~~

~~A. General Requirements for Medical Compressed-Air Manifolds: Comply with NFPA 99, "Manifolds for Gas Cylinders without Reserve Supply."~~

- ~~B. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.~~
- ~~C. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.~~
- ~~D. Compressed Air Cylinders: [Will be furnished by Owner] [Number and type of compressed-air cylinders required for complete manifold systems].~~
- ~~E. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.~~
- ~~F. Mounting: [Wall with mounting brackets for manifold control cabinet and headers] [Floor with support legs for manifold control cabinet].~~
- ~~G. Label manifold control unit with permanent label identifying compressed air and system operating pressure.~~
- ~~H. Medical Air Manifolds: For <Insert number of cylinders per bank> at 55-psig line pressure.~~
- ~~I. Instrument Air Manifolds: For <Insert number of cylinders and capacity> capacity at 200-psig minimum line pressure.~~

~~2.8 COMPRESSED-AIR-CYLINDER STORAGE RACKS~~

- ~~A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.~~
- ~~B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.~~

2.9 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

- A. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
 - 1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

- D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0- to 100-psig.
 - 2. High-Pressure Operating Range: Up to 250-psig.
- E. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
- F. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
- G. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
 - b. Instrument Air: Pressure drops below 165 psig or rises above 185 psig.
- H. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.
 - b. Instrument Air: Pressure drops below 165 psig or rises above 185 psig.

2.10 COMPUTER INTERFACE CABINET

- A. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air-piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing all alarm signals.

2.11 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Hyspan Precision Products, Inc.
 - 4. Mercer Rubber Co.

5. Metraflex, Inc.
 6. Proco Products, Inc.
 7. Unaflex.
 8. Universal Metal Hose; a Hyspan Co.
- B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: 250 psig minimum.
 2. End Connections: Threaded copper pipe or plain-end copper tube.

~~2.12 NITROGEN~~

- ~~A. Description: Comply with USP 28 NF 23 for oil free dry nitrogen, for blow down and testing.~~

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- C. Instrument Air Piping:
1. NPS 3 and Smaller: Use ~~Type K~~ Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
 2. NPS 3-1/2 and Larger: Use Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.
- D. Drain Piping: Use the following piping materials:
1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

~~E. [Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.]~~

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, special fittings and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install branch connections to compressed-air mains from top of main.
- I. Install piping to permit valve servicing.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install medical compressed-air piping to medical compressed-air outlets.
- M. Install compressed-air outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- N. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- ~~O. [Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings.]~~

3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.

- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
- F. Install pressure regulators on compressed-air piping where reduced pressure is required.
- G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
- H. Install flexible pipe connectors in discharge piping of each air compressor.

3.5 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- D. Memory-Metal Coupling "SMART TAP" Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- ~~E. [Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:~~
 - ~~1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements.~~
 - ~~2. Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.]~~

~~3.6 MEDICAL COMPRESSED-AIR SERVICE COMPONENT INSTALLATION~~

- ~~A. Install compressed-air pressure control panel in walls. Attach to substrate.~~
- ~~B. Install compressed-air manifolds anchored to substrate.~~
- ~~C. Install compressed-air cylinders and connect to manifold piping.~~
- ~~D. Install compressed-air manifolds with seismic restraints as required.~~
- ~~E. Install compressed-air cylinder wall storage racks attached to substrate.~~

3.7 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
- B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
- C. Install area and master alarm panels for medical compressed-air piping system where indicated.
- D. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.8 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Medical Air: Black letters on yellow background.
 - 2. Instrument Air: White letters on red background.

3.9 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
 - 1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical compressed-air piping.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.

- d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical air purity test.
 - k. Verify correct labeling of equipment and components.
4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
- a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.10 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 226119

COMPRESSED-AIR EQUIPMENT FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, oil-free reciprocating air compressors.
2. Packaged, oil-less reciprocating air compressors.
3. Packaged, rotary-scroll air compressors.
4. Inlet-air filters.
5. Desiccant compressed-air dryers.
6. Compressed-air purification systems.
7. Compressed-air filter assemblies.
8. Medical compressed-air equipment alarm systems.
9. Computer interface cabinet.

1.2 DEFINITIONS

- A. **Actual Air:** Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in scfm.
- B. **Low Voltage:** As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. **Medical Air Equipment:** Compressed-air equipment and accessories for healthcare facilities.
- D. **Standard Air:** Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

- A. **Product Data:** For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 1. **Wiring Diagrams:** For power, signal, and control wiring.
 2. **Short-circuit current rating of controller assembly.**
- B. **Qualification Data:** For qualified Installer and testing agency.
- C. **Field quality-control reports.**
- D. **Operation and Maintenance Data:** For compressed-air equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Air System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the compressed-air equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.
- E. Comply with NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories for medical air systems.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Medical Compressed-Air Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS

- A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; with inlet air filters and dryers, Single point of connection. continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.

2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 4. Motor Overload Protection: Overload relay in each phase.
 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 6. Wired for two power circuits, equal number of pumps per circuit.
 7. Automatic control switches to sequence lead-lag air compressors for multiplex air compressors.
 8. Instrumentation: Include discharge-air and receiver pressure gages, air-filter maintenance indicator, hour meter, air-compressor discharge-air and coolant temperature gages, and control transformer.
 9. Alarm Signal Device: For connection to alarm system to indicate high dewpoint, CO2 level high and when stand-by air compressor is operating.
 10. Short Circuit Current Ratings:
 - a. Short-Circuit Current: Match rating of overcurrent protective device serving medical air compressors.
 - b. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
1. Pressure Rating: At least as high as highest discharge pressure of connected air compressors and bearing appropriate code symbols.
 2. Interior Finish: Corrosion-resistant coating.
 3. Accessories: Include safety valve, pressure gage, automatic drain, and pressure regulator.
- D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 MANUFACTURERS

- A. Manufacturers for fully assembled packaged air compressor units:
1. Allied Healthcare Products, Inc.
 2. BeaconMedas
 3. Amico
 4. **Champion**
 5. Pattons Medical

2.3 OIL-FREE, RECIPROCATING AIR COMPRESSORS

- A. Description: Packaged unit.
- B. Air Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber and lubricated crankcase, and of construction that prohibits oil from entering compression chamber.

1. Submerged gear-type oil pump, and oil filter.
2. Intercooler between stages of two-stage units.
3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
4. Belt guard totally enclosing pulleys and belts.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 OILLESS, RECIPROCATING AIR COMPRESSORS

A. Description: Packaged unit.

B. Air Compressor(s): Single- or two-stage, oilless (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that will deliver air of quality equal to intake air.

1. High discharge-air temperature switch.
2. Belt guard totally enclosing pulleys and belts.
3. Intercooler between stages of two-stage units.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.5 ROTARY-SCROLL AIR COMPRESSORS

A. Description: Packaged unit.

B. Air Compressor(s): Single-stage, oil-free, rotary, scroll type of construction that prohibits oil from entering compression chamber.

1. Cooling System: Unit-mounted, air-cooled exchanger package.
2. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
3. Air/Coolant Receiver and Separation System: 150-psig-rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal-bypass valve.
4. Capacity Control: Capacity modulation between 0 and 100 percent air delivery, with operating pressures between 50 and 100 psig. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.
5. Mounting: Freestanding.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.6 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

- B. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
 - 1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
 - 2. Capacity: Match total capacity of connected air compressors, with collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.7 DESICCANT COMPRESSED-AIR DRYERS

- A. Manufacturers:
 - 1. BeaconMedaes.
 - 2. Domnick Hunter Limited; ZANDER, Inc.
 - 3. EMSE Corporation.
 - 4. Gardner Denver; Champion Pneumatic.
 - 5. Ingersoll-Rand; Air Solutions Group.
 - 6. Kaeser Compressors, Inc.
 - 7. Zeks Compressed Air Solutions.
- B. Description: Twin-tower unit with purge system, mufflers, and capability to deliver plus 10 deg F, 100-psig air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.
- C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.8 COMPRESSED-AIR PURIFICATION SYSTEMS

- A. Manufacturers:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. Domnick Hunter Limited; ZANDER, Inc.
 - 3. Ingersoll-Rand; Air Solutions Group.
 - 4. Kaeser Compressors, Inc.
- B. Description: Compressed-air purification system sized for maximum connected equipment capacity with coalescing, particulate, and activated-charcoal filters; compressed-air dryer; catalytic converter; gages and thermometers; and controls.
 - 1. Include the following capabilities:
 - a. Removal of excessive moisture, solid particulates, oil and oil mist, carbon monoxide, and hydrocarbon vapors.
 - b. Automatic ejection of condensate from airstream.
 - c. Production of air complying with USP - NF for medical air.
 - d. Capacity and dew point indicated, but not higher than 35 deg F at 100 psig.
 - 2. Filters: Parallel duplex filters, each sized for maximum system demand, with valved bypass for filter servicing.
 - a. Inlet Filters: 5 micrometers.
 - b. Outlet Filters: 1 micrometer(s).

3. Accessories: Inlet and outlet pressure gages, thermometers, safety valves, and shutoff valves; and automatic ejection of condensate from airstream.
4. Differential Pressure Switch: Adjustable, diaphragm type, with electrical connections for alarm system, to indicate when air-pressure drop through filters rises to more than 2 psig greater than when new and clean.
 - a. Inlet Connection: From inlet to particulate filter.
 - b. Outlet Connection: To outlet from final activated-charcoal filter.
5. Compressed-Air Dryer: Twin-tower desiccant type with automatic controls, purge system, and mufflers.

C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.9 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEMS

- A. General Requirements for Medical Compressed-Air Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for medical compressed-air piping and alarm systems. Power wiring is specified in Division 26 Sections.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
 1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.
- D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 1. Low-Pressure Switches: 0- to 100-psig operating range.
 2. High-Pressure Switches: Up to 250-psig operating range.
- E. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
- F. General Requirements for Medical Compressed-Air Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 1. Mounting: Exposed, surface installation.
 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

2.10 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.11 COMPUTER INTERFACE CABINET

- A. Description:
 - 1. Wall mounting.
 - 2. Welded steel with white-enamel finish.
 - 3. Gasketed door.
 - 4. Grounding device.
 - 5. Factory-installed signal circuit boards.
 - 6. Power transformer.
 - 7. Circuit breaker.
 - 8. Wiring terminal board.
 - 9. Internal wiring capable of interfacing all alarm signals.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean compressed-air equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical air applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

3.2 COMPRESSED-AIR EQUIPMENT INSTALLATION

- A. Install compressed-air equipment for healthcare facilities according to ASSE 6010 and NFPA 99.
- B. Equipment Mounting: Install vacuum producers on concrete bases using elastomeric pads ~~elastomeric mounts~~ restrained spring isolators. Comply with requirements in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 1. Minimum Deflection: 1/4 inch ~~[1 inch]~~.
 - 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install equipment anchored to substrate.

- D. Orient equipment so controls and devices are accessible for servicing with clearances per the NEC.
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. General Requirements for Compressed-Air Equipment Installation:
 - 1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
 - 2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.
 - 3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
 - 4. Install equipment to allow right of way for piping installed at required slope.
 - 5. Install the following devices on compressed-air equipment:
 - a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
 - b. Pressure Regulators: Install downstream from air compressors, dryers, purification units, and filter assemblies.
 - c. Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 MEDICAL COMPRESSED-AIR EQUIPMENT ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air equipment may be combined in single panels with medical vacuum equipment and medical gas piping systems.
- B. Install medical compressed-air equipment alarm system components in locations required by and according to NFPA 99.

3.4 COMPUTER INTERFACE CABINET INSTALLATION

- A. Install computer interface cabinet with connection to medical compressed-air piping alarm system and to facility computer.

3.5 CONNECTIONS

- A. Comply with requirements for water-supply piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Comply with requirements for compressed-air piping specified in Division 22 Section "Compressed-Air Piping for Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Install piping adjacent to equipment to allow service and maintenance.

- E. Connect compressed-air piping to compressed-air equipment, accessories, and specialties with shutoff valve and union or flanged connection.

3.6 IDENTIFICATION

- A. Identify medical compressed-air equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and comply with NFPA 99.

3.7 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL COMPRESSED-AIR EQUIPMENT

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Medical Compressed-Air Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air equipment concurrently with tests, inspections, and certification of medical vacuum equipment, medical vacuum piping, medical compressed-air piping and medical gas piping systems.
 - 2. Preparation: Perform medical compressed-air equipment tests according to requirements in NFPA 99 for the following:
 - a. Air-quality purity test.
 - b. System operation test.
 - 3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical compressed-air equipment.
 - 4. Replace damaged and malfunctioning controls and equipment.
 - 5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- E. Components will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that air-compressor inlet filters and piping are clear.
 - 5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 - 6. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
 - 7. Check for proper seismic restraints.
 - 8. Drain receiver tanks.
 - 9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 10. Test and adjust controls and safeties.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors, compressed-air dryer, compressed-air purification units.

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SECTION 226213

VACUUM PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at ~~[15 inches mercury]~~ 20 inches mercury ~~[30 inches mercury]~~ <Insert vacuum>.
- ~~2. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at [14 inches mercury] [15 inches mercury] <Insert vacuum>.~~

B. Related Sections include the following:

1. Division 11 Section "Laboratory Fume Hoods" for vacuum outlets in laboratory fume hoods.
2. Division 12 Section "Laboratory Casework" for vacuum outlets in casework.
3. Division 12 Section "Healthcare Casework" for vacuum outlets in metal medical casework.
4. Division 22 Section "Vacuum Equipment for Healthcare Facilities" for medical vacuum producers.
5. Division 22 Section "Vacuum Piping for Laboratory Facilities" for laboratory vacuum piping.
6. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for hangers and supports.
7. Division 22 Section "Common Work Results for Plumbing" for Sleeves and Escutcheons.

1.2 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. HVE: High-volume (oral) evacuation.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. WAGD: Waste anesthetic gas disposal.
- E. Medical vacuum piping systems include medical vacuum and WAGD evacuation piping systems.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Vacuum pipes tubes and fittings.
2. Vacuum valves and valve boxes.

- 3. Medical vacuum outlets and vacuum-bottle brackets.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain vacuum outlets of same type and from same manufacture as provided for in Division 22 Section "Gas Piping for Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Medical Vacuum Service(s): Do not interrupt medical vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of medical vacuum service(s).

2. Do not proceed with interruption of medical vacuum service(s) without Owner's written permission.

1.6 COORDINATION

- A. Coordinate medical vacuum outlets with other medical gas outlets. Medical compressed-air outlets are specified in Division 22 Section "Medical Compressed-Air Piping for Healthcare Facilities," and medical gas outlets are specified in Division 22 Section "Gas Piping for Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
- B. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.
 1. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
 3. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
- C. Memory-Metal Couplings "SMART TAP": Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
 1. Manufacturers:
 - a. Smart Technology, Inc.
 - b. <Insert manufacturer's name>.
- D. PVC Pipe: ASTM D 1785, Schedule 40. (Protective conduit)
 1. PVC Fittings: ASTM D 2466, Schedule 40, socket type.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- B. Threaded-Joint Tape: PTFE.
- C. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.

- D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- E. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

- 2.3 Manufacturers for All products listed below including valves, zone valve boxes and alarms:
- a. Allied Healthcare Products, Inc.
 - b. Amico Corporation.
 - c. BeaconMedaes.

2.4 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Copper-Alloy Butterfly Valves:
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever type with locking device.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Bronze Check Valves: In-line pattern.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Operation: Spring loaded.
 - 3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Pressure Rating: 300 psig minimum.
 - 2. Ball: Full-port, chrome-plated brass.
 - 3. Seats: PTFE or TFE.
 - 4. Handle: Lever.
 - 5. Stem: Blowout proof with PTFE or TFE seal.
 - 6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 7. Vacuum Gage: Manufacturer installed on one copper-tube extension.
- F. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

1. Interior Finish: Factory-applied white enamel.
 2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
 3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- G. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

2.5 MEDICAL VACUUM OUTLETS

- A. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body inlet block.
 - c. Seals that will prevent vacuum leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Seals that will prevent vacuum leakage.
 - c. Cover plate with gas-service label.
 3. Quick-Coupler gas outlets: Suction inlets for medical vacuum and WAGD evacuation service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
 4. D.I.S.S. gas outlets: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Vacuum outlets: CGA V-5, D.I.S.S. No. 1220.
 - b. WAGD Evacuation outlets: CGA V-5, D.I.S.S. No. 2220.
 5. Vacuum Slides: One piece, with pattern and finish matching corresponding service cover plate.
 6. Cover Plates: One piece, ~~stainless steel, with NAAMM AMP 503, No. 4 finish~~ metal, with chrome-plated finish ~~anodized aluminum~~ and permanent, color-coded, identifying label matching corresponding service.

2.6 MEDICAL VACUUM PIPING ALARM SYSTEMS

- A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

- C. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Vacuum Operating Range: 0- to 30-in. Hg.
- D. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
- E. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
 - b. ~~WAGD Evacuation: Vacuum drops below 12-in. Hg.~~
- F. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
 - 1. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg.
 - b. ~~WAGD Evacuation: Vacuum drops below 12-in. Hg.~~

2.7 COMPUTER INTERFACE CABINET

- A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing all alarm signals.

2.8 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Flex-Hose Co., Inc.
 - 2. Flexicraft Industries.
 - 3. Hyspan Precision Products, Inc.
 - 4. Mercer Rubber Co.
 - 5. Metraflex, Inc.
 - 6. Proco Products, Inc.
 - 7. Unaflex.
 - 8. Universal Metal Hose; a Hyspan Co.
- B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 200 psig ~~250 psig~~ minimum.

2. End Connections: Threaded copper pipe or plain-end copper tube.

2.9 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen, for blow down and testing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Connect new copper tubing to existing tubing with memory-metal couplings.
- B. Medical Vacuum Piping: Use the following piping materials for each size range:
 1. NPS 8 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

~~C. WAGD Evacuation Piping: Use the following piping materials for each size range:~~

- ~~1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.~~

- D. Drain Piping: Use the following piping materials:
 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

~~E. [Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.]~~

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Comply with ASSE Standard #6010 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install medical vacuum piping to medical vacuum outlets specified in this Section and to equipment specified in other Sections requiring medical vacuum service.
- K. Install medical vacuum outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- L. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- M. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- N. [Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings.]

3.4 VALVE APPLICATIONS

- A. Valves for Copper Vacuum Tubing:
 - 1. NPS 4 and Smaller: Use copper alloy ball and bronze check types.
 - 2. NPS 6 (DN 200) and larger: Use copper alloy butterfly type.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
- F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
- G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Apply appropriate tape to external pipe threads.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- E. Flanged Joints:
 - 1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- F. Memory-Metal Coupling Joints "SMART TAP": Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- G. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

- A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
- B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
- C. Install medical vacuum piping system area and master alarm panels where indicated.
- D. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.8 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Medical Vacuum: Black letters on white background.
 - 2. WAGD: White letters on violet background.

3.9 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
 - 1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
 - 2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for vacuum systems.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Final tie-in test.
 - g. Operational vacuum test.
 - h. Verify correct labeling of equipment and components.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.10 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

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SECTION 226219

VACUUM EQUIPMENT FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, oil-free, rotary claw vacuum pumps.
2. Packaged, oil-free, rotary, sliding-vane vacuum pumps.
3. Packaged, oil-sealed, rotary, sliding-vane vacuum pumps.
4. Medical vacuum equipment alarm systems.
5. Computer interface cabinets.

1.2 DEFINITIONS

- A. Actual Air:** Air delivered at vacuum producer inlet. Flow rate is air measured in expanded cfm.
- B. Low Voltage:** As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Medical vacuum equipment** includes medical vacuum equipment and accessories for healthcare facilities.
- D. Standard Air:** Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm.
- E. WAGD Evacuation:** Waste anesthetic gas disposal for medical-surgical applications in healthcare facilities.

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

- A. Product Data:** For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1. Wiring Diagrams: For power, signal, and control wiring.
 2. Short-circuit current rating of controller assembly.
- B. Qualification Data:** For qualified Installer and testing agency.
- C. Field quality-control reports.**
- D. Operation and Maintenance Data:** For vacuum equipment to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Vacuum System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.
- E. Comply with NFPA 99, "Health Care Facilities," for vacuum equipment and accessories for medical vacuum systems.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Medical Vacuum Service(s): Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's written permission.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PACKAGED VACUUM PUMPS

- A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pumps and receivers, with a single point of connection.
- B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
 - 1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.

2. Motor Controllers: Full-voltage, combination-magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
 3. Control Voltage: 120-V ac or less, using integral control power transformer.
 4. Motor Overload Protection: Overload relay in each phase.
 5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
 6. Wired for two power circuits, equal number of pumps per circuit.
 7. Automatic control switches to alternate lead-lag vacuum pumps for duplex ~~and~~ ~~sequence lead-lag vacuum pumps for multiplex~~ vacuum pumps.
 8. Instrumentation: Include vacuum pump inlet and receiver vacuum gages, hour meter, vacuum pump discharge-air and coolant temperature gages, and control transformer.
 9. Alarm Signal Device: For connection to alarm system to indicate when stand-by vacuum pump is operating.
 10. Short Circuit Current Ratings:
 - a. Short-Circuit Current: Match rating of overcurrent protective device serving vacuum equipment.
 - b. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.
- C. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; bearing appropriate code symbols.
1. Interior Finish: Corrosion-resistant coating.
 2. Accessories: Include vacuum relief valve, vacuum gage, and drain.
- D. Mounting Frame: Fabricate base and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

2.2 MANUFACTURERS

- A. Manufacturers for fully assembled packaged vacuum pump units:
1. Allied Healthcare Products, Inc.
 2. BeaconMedas
 3. Amico
 4. Pattons Medical

2.3 OIL-FREE, ROTARY CLAW VACUUM PUMPS

- A. Description: Packaged unit.
- B. Vacuum Pump(s): Oil-free, rotary, claw type.
1. Air-cooled
 2. Direct drive
 3. Heavy duty precision timing gears
 4. Outlet silencers on discharge connections.

- C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.4 OIL-FREE, ROTARY, SLIDING-VANE VACUUM PUMPS

- A. Description: Packaged unit.
- B. Vacuum Pump(s): Nonpulsating, oil-free, rotary, sliding-vane type.
 - 1. Cleanable inlet screens.
 - 2. Outlet silencers on discharge connections.
- C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.5 OIL-SEALED, ROTARY, SLIDING-VANE VACUUM PUMPS

- A. Description: Packaged unit.
- B. Vacuum Pumps: Nonpulsating, oil-sealed, rotary, sliding-vane type.
 - 1. Cleanable inlet screens.
 - 2. Outlet silencers and oil-mist separators on discharge connections.
- C. Capacities and Characteristics: REFER TO SCHEDULE ON DRAWINGS

2.6 MEDICAL VACUUM EQUIPMENT ALARM SYSTEMS

- A. General Requirements for Medical Vacuum Equipment Alarm System: Compatible alarm panels, remote sensing devices, and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Vacuum Piping for Healthcare Facilities" for medical vacuum piping and alarm systems. Power wiring is specified in Division 26 Sections.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include a minimum of two step-down transformers.
- C. Vacuum Switches or Transducer Sensors: Continuous equipment monitoring with electrical connections for alarm system.
 - 1. Vacuum Switches: 0- to 30-in. Hg vacuum operating range.
- D. General Requirements for Medical Vacuum Equipment Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Exposed, surface installation.
 - 2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

2.7 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.8 COMPUTER INTERFACE CABINET

- A. Description:
 - 1. Wall mounting.
 - 2. Welded steel with white-enamel finish.
 - 3. Gasketed door.
 - 4. Grounding device.
 - 5. Factory-installed signal circuit boards.
 - 6. Power transformer.
 - 7. Circuit breaker.
 - 8. Wiring terminal board.
 - 9. Internal wiring capable of interfacing all alarm signals.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean vacuum equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical vacuum applications, according to CGA G4.1, "Cleaning Equipment for Oxygen Service."

3.2 VACUUM EQUIPMENT INSTALLATION

- A. Install vacuum equipment for healthcare facilities according to ASSE 6010 and NFPA 99.
- B. Equipment Mounting: Install vacuum producers on concrete bases using ~~[elastomeric pads]~~ ~~[elastomeric mounts]~~ restrained spring isolators. Comply with requirements in Division 03 Section "Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - 1. Minimum Deflection: 1/4 inch ~~[1 inch]~~ ~~<Insert dimension>~~.
 - 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install vacuum equipment anchored to substrate.

- D. Orient equipment so controls and devices are accessible for servicing with clearances per the NEC.
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. General Requirements for Compressed-Air Equipment Installation:
 - 1. Install compressed-air equipment to allow maximum headroom unless specific mounting heights are indicated.
 - 2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces unless otherwise indicated.
 - 3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
 - 4. Install equipment to allow right of way for piping installed at required slope.
 - 5. Install the following devices on vacuum equipment:
 - a. Thermometer, Vacuum Gage, and Pressure Relief Valve: Install on each vacuum pump receiver.
 - b. Drain Valves: Install on receivers. Discharge receiver condensate over nearest floor drain. Discharge separator oral evacuation fluids by direct connection into sanitary waste piping system.

3.3 MEDICAL VACUUM EQUIPMENT ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical vacuum equipment may be combined in single panels with medical air equipment and medical gas piping systems.
- B. Install medical vacuum equipment alarm system components in locations required by and according to NFPA 99.

3.4 COMPUTER INTERFACE CABINET INSTALLATION

- A. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.5 CONNECTIONS

- A. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements for vacuum piping specified in Division 22 Section "Vacuum Piping for Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.
- D. Connect vacuum piping to vacuum equipment, accessories, and specialties with shutoff valve and union or flanged connection.

3.6 IDENTIFICATION

- A. Identify medical vacuum equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and with NFPA 99.

3.7 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL VACUUM EQUIPMENT

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Medical Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum equipment concurrently with tests, inspections, and certification of medical compressed-air equipment, medical compressed-air piping, medical vacuum piping and medical gas piping systems.
 - 2. Preparation: Perform medical vacuum equipment tests according to requirements in NFPA 99 for the following:
 - a. System operation test.
 - 3. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical vacuum equipment.
 - 4. Replace damaged and malfunctioning controls and equipment.
 - 5. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures and materials used.
 - c. Test methods used.
 - d. Results of tests.
- E. Components will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that vacuum producer outlet piping is clear.

5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 6. Check safety valves for correct settings.
 7. Check for proper seismic restraints.
 8. Drain receiver tank.
 9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 10. Test and adjust controls and safeties.
- B. Verify that vacuum equipment is installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.
- D. Prepare written report documenting testing procedures and results.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain vacuum producers.

END OF SECTION

SECTION 226313

GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. ~~Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at [50 to 55 psig] <Insert pressure range>.~~
2. ~~Helium piping, designated "medical helium" operating at [50 to 55 psig] <Insert pressure range>.~~
3. ~~Nitrogen piping and specialties designated "medical nitrogen" operating at [160 to 185 psig] [higher than 200 psig] <Insert pressure range>.~~
4. ~~Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at [50 to 55 psig] <Insert pressure range>.~~
5. ~~Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig~~
6. ~~<Insert specialty gas> piping and specialties designated "specialty <Insert designation>" operating at [50 to 55 psig] <Insert pressure range>.~~

B. Owner-Furnished Material:

1. ~~Medical gas manifolds.~~
2. ~~Ceiling columns.~~
3. ~~Bulk gas storage tanks.~~
4. ~~Med Gas booms.~~
5. ~~Modular Headwalls.~~
6. ~~Owner will furnish gases for medical gas concentration testing specified in this Section.~~

C. Related Sections include the following:

1. ~~Division 12 Section "Healthcare Casework" for gas outlets in metal medical casework.~~
2. ~~Division 22 Section "Compressed Air Piping for Healthcare Facilities" for compressed air piping systems for healthcare facilities.~~
3. ~~Division 22 Section "Vacuum Piping for Healthcare Facilities" for vacuum piping systems for healthcare facilities.~~

- ~~4. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for hangers and supports.~~
- ~~5. Division 22 Section "Common Work Results for Plumbing" for Sleeves and Escutcheons.~~

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter-index safety system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - ~~1. Tubes and fittings.~~
 - ~~2. Valves and valve boxes.~~
 - ~~3. Medical gas outlets.~~
 - ~~4. Electrical service connections.~~
 - ~~5. Medical nitrogen pressure control panels.~~
 - ~~6. Ceiling hose assemblies. Include integral service connections.~~
 - ~~7. Gas manifolds.~~
 - ~~8. Medical gas alarm system components.~~
 - ~~9. Gas cylinder storage racks.~~
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For specialty and medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

- ~~1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.~~

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

- ~~1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.~~

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NFPA Compliance:

- ~~1. Comply with NFPA 99, for bulk oxygen storage tanks.~~
- ~~2. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.~~

G. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.

H. UL Compliance:

- ~~1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.~~

1.5 PROJECT CONDITIONS

~~A. Interruption of Existing [Specialty] [and] [Medical] Gas Service(s): Do not interrupt [specialty] [or] [medical] gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:~~

- ~~1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of [specialty] [and] [medical] gas service(s).~~
- ~~2. Do not proceed with interruption of [specialty] [and] [medical] gas service(s) without Owner's written permission.~~

1.6 COORDINATION

- A. Coordinate medical gas outlets with other service connections. Compressed-air service connections are specified in Division 22 Sections "Compressed-Air Piping for Healthcare Facilities" and "Vacuum Piping for Healthcare Facilities."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

- ~~1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.~~
- ~~2. Wrought Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.~~
- ~~3. Memory-Metal Couplings (Smart Tap): Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.~~

- a. Manufacturers:

- 1) Smart Technology, Inc.

- B. PVC Pipe: ASTM D 1785, Schedule 40. (Protective conduit)

- ~~1. PVC Fittings: ASTM D 2466, Schedule 40; socket type.]~~

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. [Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.]

- 2.3 Manufacturers for all products listed below including valves, zone valve boxes, alarms and manifolds:

- a. Allied Healthcare Products, Inc.
 - b. Amico Corporation.
 - c. BeaconMedaes.

2.4 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. ~~Pressure Rating: 300 psig minimum.~~
 - 2. ~~Ball: Full port, chrome-plated brass.~~
 - 3. ~~Seats: PTFE or TFE.~~
 - 4. ~~Handle: Lever type with locking device.~~
 - 5. ~~Stem: Blowout proof with PTFE or TFE seal.~~
 - 6. ~~Ends: Manufacturer installed ASTM B 819, copper tube extensions.~~
- C. Check Valves: In-line pattern, bronze.
 - 1. ~~Pressure Rating: 300 psig minimum.~~
 - 2. ~~Operation: Spring loaded.~~
 - 3. ~~Ends: Manufacturer installed ASTM B 819, copper tube extensions.~~
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. ~~Pressure Rating: 300 psig minimum.~~
 - 2. ~~Ball: Full port, chrome-plated brass.~~
 - 3. ~~Seats: PTFE or TFE.~~
 - 4. ~~Handle: Lever.~~
 - 5. ~~Stem: Blowout proof with PTFE or TFE seal.~~
 - 6. ~~Ends: Manufacturer installed ASTM B 819, copper tube extensions.~~
 - 7. ~~Pressure Gage: Manufacturer installed on one copper tube extension.~~
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1. ~~Interior Finish: Factory applied white enamel.~~
 - 2. ~~Cover Plate: Aluminum or extruded anodized aluminum with frangible or removable windows.~~
 - 3. ~~Valve Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.~~

- F. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. ~~Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."~~
 2. ~~Inlet: Manufacturer installed, NPS 1, ASTM B 819, copper tubing with NPS 1 minimum ball valve and plugged inlet.~~
 3. ~~Safety Valve: Bronze body, pressure relief valve set at 75 or 80 psig.~~
 4. ~~Instrumentation: Pressure gage.~~
- G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- H. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.5 MEDICAL GAS OUTLETS

- A. General Requirements for Medical Gas Outlets: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
1. ~~Roughing in Assembly:~~
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
 - c. Double seals that will prevent gas leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 2. ~~Finishing Assembly:~~
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent gas leakage.
 - c. Cover plate with gas-service label.
 3. ~~Quick-Coupler gas outlets: Pressure outlets for [carbon dioxide] [nitrous oxide] oxygen [and] <Insert medical gas> service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive locking ring that retains equipment stem in valve during use.~~
 4. ~~D.I.S.S. gas outlets: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.~~
 - a. ~~Medical Carbon Dioxide outlets: D.I.S.S. No. 1080.~~
 - b. ~~Medical Helium outlets: D.I.S.S. No. 1060.~~

- ~~c. Medical Nitrogen outlets: D.I.S.S. No. 1120.~~
- ~~d. Medical Nitrous Oxide outlets: D.I.S.S. No. 1040.~~
- ~~e. Medical Oxygen outlets: D.I.S.S. No. 1240.~~
- ~~f. <Insert medical gas> outlets: <Insert D.I.S.S. number>, [pressure outlet] [suction inlet].~~

- ~~5. Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] metal, with chrome-plated finish and permanent, color-coded, identifying label matching corresponding service.~~

2.6 ELECTRICAL SERVICE CONNECTIONS

- A. Power Outlets: UL 498, Hospital Grade, 125-V receptacles; color selected by Architect. Include the following configurations complying with NEMA WD 1:

- ~~1. L5-20R, locking type, 20 A, single or duplex.~~
- ~~2. L5-20R, isolated ground, locking type, 20 A, single or duplex.~~
- ~~3. Explosion proof, 20 A, 2 pole, 3 wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.~~
- ~~4. 5-20R, straight blade, 20 A, duplex.~~
- ~~5. 5-20R, isolated ground, straight blade, 20 A, duplex.~~

- B. Electrical Accessory Outlets: Provide the following configured receptacles in color selected by Architect:

- ~~1. Patient Equipment Ground Jack: Single pole, 30 A.~~
- ~~2. Patient Monitoring: Single, 5 and 37 pin.~~

- C. Wall Outlet Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent identifying label.

2.7 MEDICAL NITROGEN PRESSURE CONTROL PANELS

- A. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.

- ~~1. Minimum Working Pressure: 200 psig.~~
- ~~2. Line Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.~~
- ~~3. Pressure Gages: 0 to 300 psig range.~~
- ~~4. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.~~

5. ~~Before final assembly, provide temporary dust shield and U-tube for testing.~~
6. ~~Label cover plate "Nitrogen Pressure Control."~~

2.8 CEILING HOSE ASSEMBLIES

- A. Fixed Hose Service Assemblies: Individual, concealed hose connection with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with retractor device and service connections matching hoses. Include 72 inches of conductive, CR, 1/4- or 5/16-inch-, ID, medical gas hoses rated for 200-psig minimum working pressure, and the following service hose connections:

1. ~~Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.~~
2. ~~Medical Air Hose: Quick-coupler D.I.S.S. No. 1160 pressure outlet.~~
3. ~~Medical Carbon Dioxide Hose: [Quick-coupler] [D.I.S.S. No. 1080] pressure outlet.~~
4. ~~Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.~~
5. ~~Medical Nitrous Oxide Hose: [Quick-coupler] [D.I.S.S. No. 1040] pressure outlet.~~
6. ~~Medical Oxygen Hose: Quick-coupler pressure outlet.~~
7. ~~Medical Vacuum Hose: Quick-coupler suction inlet.~~
8. ~~WAGD Evacuation Hose: [Quick-coupler] [D.I.S.S. No. 2220] suction inlet.~~
9. ~~<Insert medical gas> Hose: <Insert number and type>.~~

2.9 GAS MANIFOLDS

- A. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.

1. ~~Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line pressure regulator, shutoff valves, and safety valve.~~
2. ~~Manifold and Headers: Duplex, nonferrous metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig minimum inlet pressure, except nitrous oxide manifolds may be designed for 800 psig and carbon dioxide manifolds may be designed for 1500 psig <Insert pressure>. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.~~
3. ~~Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.~~
4. ~~Medical Carbon Dioxide Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure.~~

- ~~5. Medical Helium Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure.~~
- ~~6. Medical Nitrous Oxide Manifolds: For <Insert number of cylinders per bank> at [55-psig] <Insert pressure> line pressure, with electric heater or orifice design that will prevent freezing during high demand.~~
- ~~7. Medical Nitrogen Manifolds: For <Insert number of cylinders per bank> at [180-psig] [higher than 200-psig] <Insert pressure> line pressure.~~
- ~~8. Medical Oxygen Manifolds: For 3 cylinders per bank at 55-psig line pressure.~~
- ~~9. Medical Gas Cylinders: Will be furnished by Owner Number and type of medical gas cylinders required for complete manifold systems].~~
- ~~10. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.~~
- ~~11. Mounting: Wall with mounting brackets for manifold control cabinet and headers [Floor with support legs for manifold control cabinet].~~

2.10 GAS CYLINDER STORAGE RACKS

- A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
- B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

2.11 BULK GAS STORAGE TANKS

- A. Contractor to coordinate with owner and bulk gas supplier for bulk gas storage tanks and systems.

2.12 MEDICAL GAS PIPING ALARM SYSTEMS

- A. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- C. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - ~~1. Low Pressure Operating Range: 0 to 100-psig.~~
 - ~~2. High Pressure Operating Range: Up to 250-psig.~~
- D. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. ~~Mounting: Recessed installation.~~

2. ~~Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.~~

E. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.

1. ~~Include alarm signals when the following conditions exist:~~

a. ~~Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.~~

b. ~~Medical Helium: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.~~

c. ~~Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig and changeover is made to alternate bank.~~

d. ~~Medical Nitrous Oxide: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, and reserve level is low.~~

e. ~~Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.~~

f. Medical Oxygen: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.

g. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.

F. Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.

1. ~~Include alarm signals when the following conditions exist:~~

a. ~~Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.~~

b. ~~Medical Helium: Pressure drops below 40 psig or rises above 60 psig.~~

c. ~~Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.~~

d. ~~Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.~~

e. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.13 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing all alarm signals.

2.14 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen for blow down and testing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:
- ~~1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."~~
 - ~~2. Wash medical gas tubing and components in hot, alkaline cleaner water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.~~
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING APPLICATIONS

- A. Medical Gas Piping Except Nitrogen: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Medical Nitrogen Piping NPS 2-1/2 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- C. Medical Nitrogen Piping NPS 3 and Larger: Type K, copper tube; wrought-copper fittings; and brazed joints.
- D. [Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.]

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, equipment sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of medical gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings.
- L. Install medical gas outlets recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- M. Connect medical gas piping to medical gas sources and to medical gas outlets and equipment requiring medical gas service.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from healthcare gas supplies.
- C. Install zone valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in zone valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on gas piping where reduced pressure is required.
- F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.6 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.

- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
- D. Memory-Metal Coupling "Smart Tap" joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- E. ~~Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:~~
 - 1. ~~Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements.~~
 - 2. ~~Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.~~

3.7 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient headwall units with outlets. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
- B. Install nitrogen pressure-control panels in walls. Attach to substrate.
- C. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- D. Install gas manifolds anchored to substrate.
- E. Install gas cylinders and connect to manifold piping.
- F. Install gas manifolds with seismic restraints as indicated.

3.8 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- A. Install medical gas alarm system components in locations required by and according to NFPA 99.
- B. Install medical gas area and master alarm panels where indicated.
- C. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.9 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. ~~Carbon Dioxide: Black or white letters on gray background.~~
 - 2. ~~Helium: White letters on brown background.~~

- ~~3. Nitrogen: White letters on black background.~~
- ~~4. Nitrous Oxide: White letters on blue background.~~
- ~~5. Oxygen: White letters on green background or green letters on white background.~~

3.10 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:
 - ~~1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed air piping and medical vacuum piping systems.~~
 - ~~2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:~~
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive pressure medical gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. Repair leaks and retest until no leaks exist.
 - ~~3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:~~
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical gas concentration test.
 - k. Medical air purity test.
 - l. Verify correct labeling of equipment and components.
 - m. Verify the following source equipment:
 - 1) Medical gas supply sources.
 - ~~4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:~~

- a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.11 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 230130.51

HVAC AIR DUCT CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes cleaning of the following duct systems:
 - 1. Supply system.
 - 2. Return system.
 - 3. Exhaust system.
- B. Related Sections:
 - 1. Division 23 Section "Metal Ducts" for duct construction and connection methods.
 - 2. Division 23 Section "Air Duct Accessories" for additional duct connection requirements.

1.2 DEFINITIONS

- A. ASCS: Air system cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.
- C. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer Certificates: Signed by manufacturers certifying that products comply with requirements.
- B. Qualification Data: For ASCS.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
 - 3. Experience: Submit records of experience in the field of HVAC systems cleaning.
 - 4. Equipment, Materials, and Labor: Have equipment, materials, and labor required to perform specified services.
- B. Comply with current published standards of NADCA.

PART 2 - PRODUCTS (No products listed)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine systems to determine appropriate methods, tools, and equipment required for performance of work.
- B. Prepare written report listing conditions detrimental to performance of work.
- C. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 CLEANING

- A. Engage a qualified ASCS to clean the following systems:
 - 1. Supply system.
 - 2. Return system.
 - 3. Exhaust system.
- B. Perform cleaning before air balancing or mark position of dampers and air-directional mechanical devices before cleaning.
- C. Use duct-mounted access doors, as required, for physical and mechanical entry and for inspection.
 - 1. Install additional duct-mounting access doors to comply with duct cleaning standards. Comply with requirements in Division 23 Section "Air Duct Accessories" for additional duct-mounting access doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection. Replace damaged and deteriorated flexible ducts. Comply with requirements in Division 23 Section "Air Duct Accessories" for flexible ducts.
 - 3. Disconnect and reconnect flexible connectors as needed for cleaning and inspection. Replace damaged and deteriorated flexible connectors. Comply with requirements in Division 23 Section "Air Duct Accessories" for flexible connectors.
 - 4. Reseal rigid-fiberglass-duct systems according to NAIMA recommended practices.
 - 5. Replace damaged fusible links on fire and smoke dampers. Replacement fusible links shall be same rating as those being replaced. Comply with requirements in Division 23 Section "Air Duct Accessories" for fusible links.
 - 6. Remove and reinstall ceiling components to gain access for duct cleaning. Clean ceiling components after they have been removed and replaced.
- D. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.
- E. Particulate Collection and Odor Control:
 - 1. Where venting vacuuming system inside building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater) particles.

2. When venting vacuuming system outside building, use filtration to contain debris removed from the HVAC system and locate exhaust down wind and away from air intakes and other points of entry into building.

F. Clean the following metal-duct system components by removing visible surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling-unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators, except in ceiling plenums and mechanical room.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components.

G. Mechanical Cleaning Methodology:

1. Clean metal-duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of ducts so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct liner.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment, and do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for washdown procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present; use according to manufacturer's written instructions after removal of surface deposits and debris.

H. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal-duct systems for contaminants.
3. Where contaminants are discovered, reclean and reinspect duct systems.

3.3 CONNECTIONS

- A. Reconnect ducts to fans and air-handling units with existing flexible connectors after cleaning ducts and flexible connectors. Replace existing damaged and deteriorated flexible connectors.
- B. For fans developing static pressures of 5-inch wg and higher, cover replacement flexible connectors with loaded vinyl sheet held in place with metal straps.

- C. Reconnect terminal units to supply ducts with existing flexible ducts or replace damaged and deteriorated existing flexible ducts with maximum 12-inch lengths of new flexible duct.
- D. Reconnect diffusers or light troffer boots to low-pressure ducts with existing flexible ducts or replace damaged and deteriorated existing flexible ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Reconnect existing and new flexible ducts to metal ducts with methods described in Division 23 Section "Metal Ducts".

3.4 FIELD QUALITY CONTROL

- A. Gravimetric Analysis: Sections of metal-duct system, chosen randomly by Architect may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
 - 1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
 - 2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal-duct system shall be recleaned and reverified.
- B. Verification of Coil Cleaning: Cleaning shall restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.
- C. Report results of tests in writing.

END OF SECTION

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Common terminology and requirements used throughout this Division.
2. Requirements for Acceptance Testing Agency.
3. Requirements for Professional Engineers responsible for Delegated Design.
4. Piping materials and installation instructions common to most piping systems.
5. Transition fittings.
6. Dielectric fittings.
7. Mechanical sleeve seals.
8. Sleeves.
9. Escutcheons.
10. Grout.
11. HVAC demolition.
12. Equipment installation requirements common to equipment sections.
13. Painting and finishing.
14. Concrete bases.
15. Supports and anchorages.

1.2 RELATED DOCUMENTS

A. In addition to Division 01 Specification Sections, related sections include the following:

1. Division 01 Section "Cutting and Patching"
2. Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
3. Division 03 Sections "Cast-in-Place Concrete" and "Miscellaneous Cast-in-Place Concrete".
4. Division 05 Section "Metal Fabrications" for structural steel.
5. Division 09 Sections "Interior Painting" and "Exterior Painting".
6. Division 08 Section "Access Doors and Frames" for access panels and doors.

1.3 DEFINITIONS

A. This section includes the following definitions that are common to most Division 23 Specifications.

1. Definitions found within this section, Division 23 "Common Work Results for HVAC," are considered to generally apply to all sections unless otherwise noted.
2. Other sections may increase or decrease the scope and usage of a particular word, phrase, or abbreviation for the section in which it appears.

- B. AHJ: Authority Having Jurisdiction. This abbreviation is the general term for all agencies having oversight and/or inspection authority for a scope of work, trade, or system. AHJ includes agencies such as local and state fire marshals, city inspectors, et. al.
- C. AHU: Air handling unit. This abbreviation is the general term for systems that filter and/or changes the sensible and/or latent properties of air supplied to a space. Its use is synonymous with RTU, roof top unit, irrespective of a system's physical location.
- D. Bound Material: Bound refers to materials permanently bound, as by stitching or glue, or materials securely fastened in their covers by multiple fasteners that penetrate all papers. Ring binders, spiral binders, brads and screw posts are acceptable fasteners. Loose papers clipped together or stapled at one (1) corner are not acceptable.
- E. Business Day: Where this Section and other Sections of this Division use the term "Business Day" it shall mean Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.
- F. CAV: Constant air volume.
- G. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- H. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- I. CPVC: Chlorinated polyvinyl chloride plastic.
- J. DDC: Direct-digital controls.
- K. ECM: Electrically commutated motor.
- L. EPDM: Ethylene propylene diene monomer rubber.
- M. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- N. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- O. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- P. FMS: Facility Management System. May be used interchangeably with BAS, Building Automation System.
- Q. Furnish: The material, equipment, etc. to be supplied, but not installed by the supplier.
- R. Manufacturers:
 - 1. Available Manufacturers: When used, this allows any manufacturer in compliance with the requirements to be submitted and used for the system indicated, pending engineer's approval. The list of manufacturers is intended to illustrate typical providers.

2. Basis-of-Design: The manufacturer indicated as such is required to be furnished. The Owner reserves the right to select additional manufacturers listed and adjust the bid amount up or down as is indicated on the bid form for the selected manufacturer.
3. Manufacturers: When used, restricts the list of acceptable manufacturers to only the entities indicated that comply with the requirements detailed.
 - a. Where the product of a single manufacturer is mentioned by trade name or manufacturer's name in this Division, it is the only acceptable manufacturer.
 - b. Where two (2) or more manufacturers are named, only those manufacturers will be considered or approved.
- S. NBR: Acrylonitrile-butadiene rubber.
- T. NRTL: Nationally Recognized Testing Laboratory.
- U. PE: Polyethylene plastic.
- V. Products and Materials: Components and assemblies for the construction of the systems as indicated in the Documents including, but not limited to pipes, tubes, ducts, and equipment.
- W. Products or Materials: See "Products and Materials".
- X. Provide: The materials and equipment described shall be furnished, installed and connected under this Division, complete for operation, unless specifically noted to the contrary. Identical to the phrase "furnish and install".
- Y. PVC: Polyvinyl chloride plastic.
- Z. RTU: Rooftop unit. The abbreviation means packaged, outdoor, central station AHUs. This abbreviation may be used regardless of whether the unit is located on a roof or at grade.
- AA. VAV: Variable air volume.
- BB. VFD: Variable frequency drive. This may be used interchangeably with VSD (variable speed drive), VSC (variable speed controller), and VFMC (variable frequency motor controller). This technology varies the frequency of the incoming electrical signal to change the speed of driven equipment.

1.4 RELATED REQUIREMENTS

- A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.
- B. The Contractor shall examine and coordinate with all Contract Drawings and Specifications, and all Addenda issued. Failure to comply shall not relieve them of responsibility. The omission of details of other portions of the Work from this Division shall not be used as a basis for a request for additional compensation.
- C. The specific features and details for other portions of the Work related to the construction in progress or to the building(s) shall be determined by examination at the site.

1.5 RELATED REQUIREMENTS

- A. All conditions imposed by these documents shall be applicable to all portions of the Work under this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.

1.6 ORDINANCES, PERMITS AND CODES

- A. It shall be the Contractor's duty to perform the work and provide the materials covered by these Specifications in conformance with all ordinances and regulations of all authorities having jurisdiction.
- B. All work herein shall conform to all applicable laws, ordinances, and regulations of the local utility companies.
- C. The work shall be in accordance with, but not limited to, the requirements of:
 - 1. National Fire Protection Association
 - 2. Wichita Falls Building Codes
 - 3. Texas Safety Code
 - 4. Texas Boiler Code
 - 5. Texas Department Of State Health Services
- D. Codes and standards referred to are minimum standards. Where the requirements of these Specifications or drawings exceed those of the codes and regulations, the drawings, and Specifications govern.
- E. The Contractor shall obtain permits, plan checks, connection and specification fees, inspections, and approvals applicable to the Work as required by the regulatory authorities.
- F. Fees and costs of any nature whatsoever incidental to permits, inspections, and approvals shall be assumed and paid by the Contractor.
- G. The pro-rata costs, if any, for utilities serving this property will be paid for by the Owner and shall not be included as part of this Contract.

1.7 REFERENCE STANDARDS

- A. Where differences between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents occur, the most stringent shall govern. The Contractor shall promptly notify the Owner's Representative in writing of any such difference.
- B. Should the Contractor perform any Work that does not comply with local codes, laws and ordinances, industry standards or other governing regulations, the Work shall be corrected on noncompliance deficiencies with the Contractor bearing all costs.
- C. In addition to the aforementioned ordinances, industry standards published by the following organizations shall apply:
 - 1. AIA - AMERICAN INSTITUTE OF ARCHITECTS
 - 2. AABC - ASSOCIATED AIR BALANCE COUNCIL

3. AASHO - AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
4. ACI - AMERICAN CONCRETE INSTITUTE
5. ADC - AIR DIFFUSION COUNCIL
6. AGA - AMERICAN GAS ASSOCIATION
7. AHRI - AIR CONDITIONING HEATING & REFRIGERATION INSTITUTE
8. AISC - AMERICAN INSTITUTE OF STEEL CONSTRUCTION
9. AMCA - AIR MOVING AND CONDITIONING ASSOCIATION
10. ANSI - AMERICAN NATIONAL STANDARDS INSTITUTE
11. API - AMERICAN PETROLEUM INSTITUTE
12. ASCE - AMERICAN SOCIETY OF CIVIL ENGINEERS
13. ASHRAE - AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR
CONDITIONING ENGINEERS, INC.
14. ASME - AMERICAN SOCIETY OF MECHANICAL ENGINEERS
15. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIALS
16. AWS - AMERICAN WELDING SOCIETY CODE
17. AWWA - AMERICAN WATER WORKS ASSOCIATION
18. CDA - COPPER DEVELOPMENT ASSOCIATION
19. CISPI - CAST IRON SOIL PIPE INSTITUTE
20. CTI - COOLING TOWER INSTITUTE
21. FGI - FACILITY GUIDELINES INSTITUTE
22. FMG - FACTORY MUTUAL GLOBAL
23. ICC - INTERNATIONAL CODE COUNCIL
24. IRI - INDUSTRIAL RISK INSURERS
25. NBS - NATIONAL BUREAU OF STANDARDS
26. NFPA - NATIONAL FIRE PROTECTION ASSOCIATION
27. OSHPD - OFFICE OF STATEWIDE HEALTH PLANNING AND DEVELOPMENT
28. PDI - PLUMBING AND DRAINAGE INSTITUTE
29. SMACNA - SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL
ASSOCIATION
30. TDLR - TEXAS DEPARTMENT OF LICENSING AND REGULATION
31. TSDHS - TEXAS DEPARTMENT OF STATE HEALTH SERVICES
32. UL - UNDERWRITER'S LABORATORIES

- D. Where the Documents exceed the above requirements, the Documents shall govern. In no case shall Work be installed contrary to or below the minimum legal standards.

1.8 DRAWINGS AND SPECIFICATIONS

- A. The inter-relation of the specifications, the drawings, and the schedules are as follows:
1. The specifications provide the written requirements for the quality, standard, nature of the materials, equipment and construction systems.
 2. The drawings establish the quantities, approximate dimensions, details and location of equipment.
 3. The schedules give the capacities, characteristics and components.
- B. For any individual project, if there is conflict between the drawings and or specifications, they are equivalent in authority and priority. Should they disagree in themselves, or with each other, prices shall be based on the most expensive combination of quality and quantity of work indicated. In the event of the above mentioned disagreements the resolution shall be determined by the Architect.
- C. Contractor is responsible to bring any conflicts in drawings and/or specifications to the attention of the Architect, immediately, prior to any work being done.

- D. Review all construction details illustrated on the architectural and structural drawings and be guided thereby.

1.9 SUBMITTAL PROCEDURES

- A. Simultaneous Action Submittals: When submittals are required and a simultaneous action is indicated, the equipment is to be coordinated across trades prior to forwarding to the Engineer.
 - 1. The release of mechanical equipment submittals (pumps, air handling units, chillers, fans cooling towers, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study as required by Division 26.
 - 2. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement.
 - 3. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process.
 - 4. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- B. Documents for submittal may be hard copies in a three ring binder or soft copies in an electronic file using the Portable Document Format (PDF) standard. In any case, where multiple products, trades, floors, disciplines, etc. are combined into one (1) submittal, provide tabs for binders or 'bookmarks' for PDF files for efficient navigation between items to be reviewed and a table of contents at the front. Documents that do not conform may be rejected.
- C. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
 - 1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.
 - 2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files shall be in Portable Document Format (.pdf).
 - 3. Product Data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.
- D. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
 - 1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®.
 - 2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 - 3. In addition to hardcopies required by Division 01, submit one (1) copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).

4. Shop Drawings shall be of appropriate scale based on the following:
 - a. Ductwork and Piping Systems, including all underfloor work:
Minimum 1/8" = 1'-0".
 - 1) Double-line congested areas.
 - 2) Double-line duct widths greater than 24".
 - b. Mechanical rooms: 1/4" = 1' – 0".
 - 1) Double-line all systems.
 - c. Temperature Control Diagrams with Sequence of Operations on same drawing.
 5. Shop drawings shall include the following items:
 - a. Concrete pads and foundations.
 - b. Equipment room layouts with actual dimensions and offsets for all systems.
 - c. Roof layouts.
 - d. Trench locations and sizes.
 - e. Dimensioned floor drain locations.
- E. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project Management and Coordination". In addition to the requirements of Division 01 comply with the following:
1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.
 2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 3. In addition to hardcopies required by Division 01, submit one (1) copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
 4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
- F. Coordination Drawings: Prepare drawings showing dimensioned layout for the following:
1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.
 2. Reflected Ceiling Plans: ceiling plans, sections, and other necessary details showing dimensioned layouts for equipment located in or on the ceiling plane. Base dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the all items in the ceiling plane coordinated with each other, based on input from installers of the items involved.
 3. Include the following items coordinated with each other, based on input from installers of the items involved:
 - a. Suspended ceiling components.

- b. Structural members to which suspension systems for luminaires will be attached.
- c. Perimeter moldings, decorative ceiling elements, and Architectural features.
- d. Luminaires.
- e. HVAC Diffusers, Registers and Grilles.
- f. Speakers.
- g. Sprinklers.
- h. Fire Alarm initiating devices, including but not limited to the following:
 - 1) Smoke detectors.
 - 2) Heat detectors.
- i. Fire Alarm notification appliances.
- j. Occupancy sensors.
- k. Access panels.
- l. Security cameras and occupancy detectors.
- m. Wireless Access Points.
- n. Wiring Diagrams
- o. Short-circuit current rating of equipment assembly.

4. HVAC Layouts:

- a. Single-line drawings of duct and piping systems are satisfactory except for the following, which shall be double-lined:
 - 1) All mechanical equipment rooms.
 - 2) Main duct runs to and from air handling equipment rooms.
 - 3) Ductwork and piping in congested areas.
 - 4) Ductwork with widths 36" and greater.
- b. Shop drawings shall be provided for the following:
 - 1) Sheet Metal and Duct Systems, including all underfloor work (prepared at a minimum scale of 1/8"=1'-0")
 - 2) Piping and equipment systems for chilled water, condenser water, refrigerant, heating water, steam and other HVAC piping systems. (Preferably at 1/4" = 1' – 0" and not less than 1/8" = 1' – 0").
 - 3) Equipment room layouts with actual equipment, piping, and duct at 1/4" = 1' – 0" scale. Show clearances, access spaces, relative heights of piping, main ducts, outside and relief louvers. Provide at least one (1) section through each equipment room showing the same.
 - 4) Temperature Control Diagrams with Sequence of Operations on same drawing.
 - 5) Housekeeping and equipment concrete pads.
 - 6) Dimensioned floor drain locations and the equipment each serves.
 - 7) Roof layouts.
 - 8) Trench locations and sizes.
 - 9) Catwalk or equipment maintenance platform assemblies.
- c. Equipment support locations, type of support, and weight on each support.
- d. Location of structural supports for structure-supported raceways.
- e. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.
- f. **Location of structural supports for seismic bracing.**

- G. Common Requirements for Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" for "Other Informational Submittals". In addition to the requirements of Division 01 comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with "Compliance". Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
 - a. "C" for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - b. "D" for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
 - c. "A" for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
 - d. "N/A" for Not Applicable: By noting the term "not applicable" or "N/A" in the margin, it shall be understood that the specified item is not applicable to the project.

- H. Common Requirements For Qualification Data:

1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a licensed Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of licensing registration in the state where the Project is located.
2. Independent Testing and Inspecting Agency Certification: Where this Section and other Sections of this Division require an Independent Testing and Inspecting agency to be responsible for Acceptance Testing and Field Quality Control requirements; submit certification documentation for such agency that demonstrates compliance with the Quality Assurance paragraph of this Section.

- I. Qualification Data: For Independent Testing and Inspecting Agency.

- J. Welding certificates.

1.10 PRODUCT SUBSTITUTIONS

- A. Comply with provisions of Division 01 Section "Product Requirements".

1. If item of equipment or device offered as Substitution differs in dimension or configuration from that indicated in the Contract Documents, provide, as part of the substitution submittal, a drawing that shows that the equipment or devices proposed for Substitution can be installed in the space available without interfering with other trades or with access requirements for operations and maintenance in the completed project. Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
2. Where substitute equipment or devices requires different arrangement or connections from that indicated in the Contract Documents, install the equipment or devices to

operate properly and in accordance with the requirements of the Contract Documents. Make incidental changes necessary in piping, ductwork or wiring which results from the inclusion of the substitute equipment or device without any additional cost to the Owner. Pay all additional costs incurred by other trades in connection with changes required by the inclusion of the substituted equipment or device in the Work.

3. When submitting a manufacturer that is not the Basis of Design, the Contractor shall provide an itemized list of all deviations from and compliances with the information detailed in both the specification section and schedule. An additional itemized list shall account for scope increase and deductions based on substitutions for the following minimum items:

- a. Electrical panels, distribution, and safeties.
- b. Structural modifications.
- c. Civil modifications.
- d. Plumbing modifications.
- e. Duct and pipe connections or arrangements.
- f. Space heating and cooling requirements.
- g. Exhaust or ventilation modifications.
- h. Seismic restraint modifications.
- i. Vibration isolation requirements.

- B. Manufacturers not listed are subject to design Engineer's review and may not be acceptable. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum ten (10) business days prior to bid with each sub-paragraph noted with the comment, "compliance", "deviation", "alternate" or "not applicable" as described above. In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.
- C. Where substitute products or materials requiring different arrangement or connections from that indicated are accepted by the Owner's Representative, install the equipment or devices to operate properly and in harmony with the intent of the Documents, making all incidental changes in piping, ductwork, wiring, and any other trade resulting from the substitution without any additional cost to the Owner.
- D. The Owner's Representative reserves the right to call for samples of any item of product or material offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.
- E. When any request for a substitution of a product or material is submitted and rejected, the item named in the Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.

1.11 QUALITY ASSURANCE

- A. All Work shall be performed by properly licensed technicians skilled in their respective trades. All materials, equipment and devices shall be installed in accordance with the recommendations of the manufacturer and in the best standard practice to bring about results of a first class condition.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- C. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved in the systems they are working on and that certification is current.
- D. Electrical Characteristics for HVAC Equipment:
 - 1. Equipment having higher electrical characteristics other than those specified should be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
 - 2. Where variable frequency drives are provided for equipment, whether installed separately or integral to the equipment, the VFDs shall conform to Division 26 Section, "Variable Frequency Motor Controllers".
- E. Wherever a UL standard has been established for a particular type of material, equipment or device, each item of such material, equipment or device provided on this project shall meet the requirements of the UL standard in every way, and shall be UL listed and labeled.
- F. Products and materials shall be of the best quality customarily applied in quality commercial practice, and shall be by reputable manufacturers.
- G. Each major component shall bear a nameplate giving the name and address of the manufacturer, and the catalog number or designation of the component.
- H. Products and materials provided under this Division of the Specifications shall be essentially the standard item, unless otherwise noted, of the specified manufacturer, or where allowed, an alternate manufacturer.
- I. Common Requirements for Independent Testing and Inspecting Agency Qualifications: Where this Section and other Sections of this Division call for an Independent Testing and Inspecting Agency (Testing Agency); the Testing Agency shall comply with the following requirements:
 - 1. Have the experience and capability to conduct the testing indicated,
 - 2. Be a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to the AHJ and the Engineer-of-Record.
 - 3. Meet the following:
 - a. Be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated.
 - b. Be regularly engaged in the testing of seismic support of HVAC equipment devices, installations, and systems.
 - c. Use technicians who are regularly employed for testing services.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products and materials with factory-applied end caps or "heat shrink" wrappings to protect openings. Maintain opening protection through shipping, storage, and handling to prevent damage and the entrance of dirt, debris, and moisture.

- B. Store light sensitive products and materials away from and protected against direct sunlight.
- C. Support products and materials at all times to prevent sagging and bending.
- D. The area provided for product and material storage at the jobsite shall be clean, dry and exposure to dust minimized.
- E. Responsibility for the protection of products and materials shall extend to existing equipment, systems, and products and materials. Erect temporary sheltering structures, provide temporary bracing and supports, or cover existing equipment, systems, and products and materials to prevent damage and the entrance of dirt, debris, and moisture.
- F. Failure on the part of the Contractor to comply with the above to the satisfaction of the Architect, Engineer, or either's authorized representative shall be sufficient cause for the rejection of products and materials in question.

1.13 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.
- D. Installation Drawings
 - 1. Prepare special drawings as called for elsewhere herein or directed by the Architect to coordinate this work with the work of other Divisions, to illustrate changes in this work to facilitate its concealment in finished spaces, to avoid obstructions, or to illustrate the installation of a substitute equipment item.
 - 2. Use these drawings in the field for the installation of all systems and components. Unless otherwise directed, do not submit these drawings for review, but provide 3 copies to the Architect for information.
- E. ACTION SUBMITTALS

- 1. Product Data: For the following:
 - a. Dielectric fittings.
 - b. Mechanical sleeve seals.
 - c. Escutcheons.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. All piping and tubing shall be American manufactured, unless otherwise indicated.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Innerlynx.
 - b. Link-Seal by PSI.
 - c. Metraflex Co.
 - 2. Sealing Elements: EPDM for high temperature applications and NBR for all others unless otherwise indicated, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe. Seal shall be same manufacturer as sleeve.
 - 3. Pressure Plates: Stainless steel. Include two (2) for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one (1) for each sealing element.

2.5 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 10, galvanized, plain ends.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.
- C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated and rough brass, pending approval by Architect.
- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- E. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SCOPE OF WORK

A. Inspection of Site

1. The accompanying drawings do not indicate existing mechanical installations other than to identify modifications of and extensions thereof. Site visits and installation inspections to ascertain the conditions to be met are included in the scope.
2. Failure to comply with an inspection of the site shall not constitute ground for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work under this Division.
3. Review all construction details of the new portion of the building as illustrated on the architectural and structural drawings and be guided thereby.

B. Products and Materials Description

1. Where two (2) or more units of the same kind or class of a specific item are required, these shall be the products of a single manufacturer; however, the component parts of the item need not be the products of one (1) manufacturer.
2. In describing the various products and materials, in general each item will be described singularly, even though there may be a multiplicity of identical items. Also, where the description is only general in nature, exact sizes, duties, space arrangements, horsepower requirements and other data shall be determined by reference to the Documents.

C. Refer to other Divisions of the Specifications for related Work.

D. Install, hang, support, etc. all MEP systems and equipment to satisfy all requirements of the applicable seismic zone using performance requirements and design criteria for project site as indicated by Architect.

E. It is the intent, unless otherwise indicated, that all products and materials described and specified under this Division, shall be provided for a complete working system irrespective of use of the phrases "install", "furnish", "furnish and install", or "provide" as described above has been actually included.

F. The Contractor is responsible for all Work of every description in connection with this Division of the Specifications.

G. The Contractor specifically and distinctly assumes all risk for damage or injury from whatever cause to property or person used or employed on or in connection with this Work and of all damages or injury to any person or property wherever located, resulting from an action or operation under the Contract in connection with the Work, and undertake the promise to defend the Owner against all claims on account of any such damage or injury.

H. The Contractor will be held responsible for the satisfactory execution and completion of the Work in accordance with the true intent of the Documents.

- I. Provide without extra charge all incidental items required as part of the Work, even though it may not be specifically indicated. If the Contractor has reason for objecting to the use of any material, equipment, device or method of construction as indicated, he shall make report of such objections to the Owner's Representative, obtain proper approval and adjustment to the Contract, and shall proceed with the Work.

J. Electrical Installation

- 1. All electric wiring shall be installed under Division 26, except for such equipment items as are prewired at their point of manufacture and so delivered to the project, and except for the following:
 - a. Temperature Control Wiring and Power Wiring provided by controls contractor.
- 2. Prepare and submit for review wiring diagrams for all equipment furnished under this Division. Show on these diagrams all power, interlock, and control circuits. When the Architect takes no exception to these drawings, they shall become installation drawings for the Contractor.
- 3. All chilled water, condenser water piping, domestic cold and hot water piping, and wet fire protection system shall be heat traced when routed external to the building or in areas susceptible to freezing conditions.

3.2 Schedule And Sequence Of Work

- A. The Contractor shall meet and cooperate with the Owner and Owner's Representative to schedule and sequence Work so as to ensure meeting scheduled completion dates and avoid delaying other portions of the Work. Work requiring special sequencing shall be at no additional cost to the Owner and shall have no impact on the schedule.
- B. Work schedules and completion dates as established shall be rigidly adhered to. Cooperate in establishing these schedules and perform the work under this Division at such times as directed so as to ensure meeting scheduled dates and avoid delaying any other Contractor.
- C. Any work involving a service suspension shall be scheduled in advance with the Owner.
- D. Should it be necessary to perform certain operations on an "overtime" basis in order not to interrupt the normal usage of the facility, include the costs of such overtime without change in the Contract amount.

3.3 TEMPORARY HEATING AND COOLING

- A. Provide all temporary heating and cooling equipment for spaces that require continued use.
- B. Should the work in the designated areas affect any services to areas that are to remain in use, provide temporary services as required to enable those occupied areas to function properly. Additional valves, ductwork, equipment and piping required shall be installed without added cost to the Owner.

3.4 HVAC DEMOLITION

- A. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.5 SALVAGED MATERIALS

- A. Reuse no salvaged material except as noted on the Drawings, specified herein, or directed by the Architect. Remove from the premises all present materials falling under this Division, which are removed from the existing building. Upon completion, leave no "dead" line or equipment installed in any portion of the area being remodeled, unless otherwise indicated.

3.6 ACCESS – COMMON REQUIREMENTS

- A. Provide an access door in non-lay-in ceilings to maintain and inspect HVAC components. Components include, but are not limited to, the following:
1. Actuators.
 2. Control Modules.
 3. Filter Boxes.
 4. Fire Protectives.
 5. Manual balancing dampers.
 6. Terminal boxes.
 7. Valves.
- B. Unless otherwise indicated, access door shall provide a minimum clear opening of 30" x 30".

3.7 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons, after Architect's final approval of finish, for penetrations of walls, ceilings, and floors according to the following:
 - 1. New piping penetrations shall be one-piece escutcheons.
 - 2. Existing piping penetrations shall be two-piece escutcheons.
 - 3. All sleeved penetrations shall be deep-drawn allow flush installation between escutcheon and finished surface.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board rated partitions, and concrete floor and roof slabs.
 - 1. Penetration assemblies shall comply with U.L. Fire Resistance Directory requirements for wall penetrations.
 - 2. Cut sleeves to length for mounting flush with both surfaces, unless otherwise indicated.
 - a. Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level to prevent water entrance into sleeved hole. Vertical pipe supports must be extended to and be supported by the floor rather than the sleeve.
 - b. Provide concrete pipe curb in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level, minimum, in lieu of extended sleeves.
 - 3. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 4. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

- 1) Seal space outside of sleeve fittings with grout.
5. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- N. Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter for above ground locations.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter for above ground and all underground locations.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.8 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
 - E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.9 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.10 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Equipment called for on the plans and not listed herein shall be provided as though it were fully described herein.
- B. Equipment called for herein shall be completely provided, whether fully detailed or not on the plans, and/or scheduled.
- C. All equipment as indicated on the plans and as described herein shall be installed per manufacturer's recommendations to allow for proper operation and maintenance of the equipment.
- D. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- F. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

- G. Where any piece of equipment is too large for ingress through normal building openings, it shall be placed in its containing space before the enclosing structure is completed.
- H. Install equipment to allow right of way for piping installed at required slope.

3.11 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.12 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases not less than 4 inches larger in both directions than supported unit.
 - 2. Concrete bases for internally isolated AHU's shall be 6 inches (150 mm) tall above finished floor.
 - 3. Concrete bases for all other equipment shall be 4 inches (100 mm) tall above finished floor.

3.13 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.14 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.15 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.

- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.16 INSTALLATION INSPECTIONS AND CERTIFICATIONS

- A. The Contractor shall obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspecting authority.
- B. Upon final completion of the work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Architect for transmission to the Owner.

3.17 OPERATION PRIOR TO COMPLETION

- A. When any piece of mechanical or electrical equipment is operable and it is to the advantage of the contractor to operate the equipment, he may do so with permission of Owner, providing that he properly supervises the operation, retains full responsibility for the equipment operated, and protects against dirt accumulations during operation. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner or until final acceptance by the Owner.
- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, and properly adjust the operation of the equipment before final acceptance by the Owner.
- C. All equipment is to be maintained per the manufacturer's instructions until Owner's maintenance staff is responsible for operation and upkeep.

3.18 INSTRUCTION OF OWNER'S PERSONNEL

- A. Provide the services of competent engineers and/or technicians acceptable to the Owner's Representative to instruct other representatives of the Owner in the complete and detailed operation of each item of equipment or device of all the various electrical systems. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results.
- B. Upon completion of these instructions, the Contractor shall obtain a letter of release, acknowledged by the Owner or his authorized representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.
- C. The Contractor shall be fully responsible for proper maintenance of equipment and systems until the instructions have been given the Owner's personnel and the letter of release acknowledged.
- D. In providing the instructions to the Owner's personnel, the written operating and maintenance manuals shall be followed in all instances, and the Owner's personnel shall be familiarized with such manuals.

- E. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturer's operating and maintenance instructions, parts lists (with sources identified), and other data as appropriate for each system.

3.19 SEALANT

- A. Apply sealant to penetrations of all floor and wall assemblies to maintain pressure differentials required by AIA for all pressure sensitive rooms.
- B. Pressure sensitive rooms include, but are not limited to:
 - 1. Central sterile clean and decontamination rooms.
- C. Sealant materials and installation requirements are specified in Division 07 Section "Joint Sealants" and Division 09 Section "Gypsum Board Assemblies."

END OF SECTION

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SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Related Sections include the following:
 - 1. Division 26 Section "Enclosed Controllers".
 - 2. Division 26 Section "Variable Frequency Drives".

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

1.3 WARRANTY

- A. All inverter-duty motors shall have minimum 5-year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. MagneTek/Century
- B. Lincoln
- C. Marathon
- D. General Electric
- E. Gould
- F. Toshiba

- G. Baldor
- H. Reliance
- I. US Motors

2.2 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.3 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 POLYPHASE MOTORS

- A. Description: $\frac{3}{4}$ hp and larger NEMA MG 1, Design B, medium induction motor, unless otherwise indicated.
- B. Efficiency: Provide premium efficiency type for all motors 1 HP and greater and conform to the minimum efficiencies as listed in ASHRAE 90.1-2013.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

- 2. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- L. Provide shaft grounding rings.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Spike-proof inverter motor such that voltage spikes will not damage motor insulation.
 - 2. No distance restrictions between any inverter and motor.
 - 3. No frequency limitations.
 - 4. Inverter power conditioning equipment shall not be required to protect motor.
- C. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 1. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.6 SINGLE-PHASE MOTORS

- A. Motors less than $\frac{3}{4}$ hp shall be one of the following to suit starting torque and requirements of specific motor application, unless noted otherwise:
- B. Permanent-split capacitor.
 - 1. Split phase.
 - 2. Capacitor start, inductor run.
 - 3. Capacitor start, capacitor run.
- C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- D. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- E. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor

insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.7 MOTOR ENCLOSURES

- A. Provide motor enclosures according to the following list as a minimum, unless recommended by the manufacturer for the given application or unless indicated otherwise.
 - 1. Indoor Service: ODP type.
 - 2. Outdoor Service: TEFC type.
 - 3. Inside an Air Stream: For fan motors installed in the air stream by the fan manufacturer the motor enclosure shall be TEAO unless indicated otherwise by the manufacturer.
 - 4. Hazardous Service: For NEC hazardous locations motor enclosures shall be rated for the division, class, and group indicated or required.

PART 3 - EXECUTION

3.1 STARTER AND MOTOR CONTROLS

- A. Provide a suitable NEMA rated starter, one per motor, for control of each motor furnished under this Division. All motors 3/4 horsepower and larger require magnetic or electronic starters, no exceptions. All motors of any size that are automatically controlled require "Hand-Auto" or "Hand-off-Auto" magnetic or electronic starters, no exceptions. All magnetic and electronic starters shall have H-O-A switches.
- B. Provide each motor that does not require a starter, a manual starting switch with thermal overload protection with identifying nameplate, green pilot light and stainless steel cover plate equal to Westinghouse Type MS. Switches installed on finished walls shall be flush type.
- C. Starter shall have overload protection on all phases. This will require three overload relays for three phase motors and one overload relay for one phase/line voltage motor. Provide NEMA 1B control voltage transformer, "on" green pilot light, and 1-normally open and 2-normally closed auxiliary contacts on each starter, unless otherwise noted.
- D. Certain starters and motor controls for motors furnished under this Division are scheduled on the Drawings to be elements of motor control centers provided under Division 26. Except for those scheduled starters, provide a suitable starter for control of each motor furnished under this Division.
- E. Each starter shall have a capacity rating within the required limits of the motor which it serves; it shall have overload elements selected to provide protection for the motor.
- F. Where a combination starter and disconnect switch or starter and circuit breaker in a common enclosure is scheduled, provide auxiliary contacts on the switch or breaker as required to assure that, when the disconnecting means is open, there are no "live" contact points on the starter.
- G. Where a holding coil voltage differs from line voltage, install a transformer with secondary fusing in the starter enclosure.
- H. Unless otherwise indicated, furnish starters mounted indoors with NEMA Type 1 enclosures; and furnish those exposed to the weather with NEMA Type 3R enclosures.

- I. Where starters are not installed in heated and cooled spaces, the heater elements shall be of the ambient temperature-compensated, bimetallic type.

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SECTION 230516

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal-bellows expansion joints.
 - 2. Expansion compensators.
 - 3. Rubber expansion joints.
 - 4. Flexible-hose expansion joints.
 - 5. Packed slip expansion joints.
 - 6. Flexible ball joints.
 - 7. Pipe bends and loops.
 - 8. Alignment guides and anchors.

1.2 DEFINITIONS

- A. BR: Butyl rubber.
- B. Buna-N: Nitrile rubber.
- C. CR: Chlorosulfonated polyethylene synthetic rubber.
- D. CSM: Chlorosulfonyl-polyethylene rubber.
- E. EPDM: Ethylene-propylene-diene terpolymer rubber.
- F. NR: Natural rubber.
- G. PTFE: Polytetrafluoroethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

- A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

1. Manufacturers:
 - a. Adsko Manufacturing, LLC.
 - b. Anamet, Inc.
 - c. Badger Industries.
 - d. Expansion Joint Systems, Inc.
 - e. Flex-Hose Co., Inc.
 - f. Flexicraft Industries.
 - g. Flex-Pression, Ltd.
 - h. Flex-Weld, Inc.
 - i. Hyspan Precision Products, Inc.
 - j. Metraflex, Inc.
 - k. Piping Technology & Products, Inc.
 - l. Proco Products, Inc.
 - m. Senior Flexonics, Inc.; Pathway Division.
 - n. Tozen America Corp.
 - o. Unaflex Inc.
 - p. WahlcoMetroflex.

2. Metal-Bellows Expansion Joints for Copper Piping: Multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
 3. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
 4. Metal-Bellows Expansion Joints for Steel Piping: Multiple-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
 5. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
 6. Configuration: Double-bellows type with base, unless otherwise indicated.
 7. End Connections: Flanged.
- B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, antitorque device, and removable end clip for positioning.
1. Manufacturers:
 - a. Adscro Manufacturing, LLC.
 - b. Flexicraft Industries.
 - c. Flex-Pression, Ltd.
 - d. Flex-Weld, Inc.
 - e. Hyspan Precision Products, Inc.
 - f. Metraflex, Inc.
 - g. Senior Flexonics, Inc.; Pathway Division.
 - h. Unaflex Inc.
 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
 3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
 4. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
 5. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
 6. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
 7. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 8. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or threaded.
- C. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
1. Manufacturers:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex-Weld, Inc.
 - d. Garlock Sealing Technologies.
 - e. General Rubber Corp.
 - f. Mason Industries, Inc.; Mercer Rubber Co.
 - g. Metraflex, Inc.
 - h. MG Piping Products Co.
 - i. Proco Products, Inc.
 - j. Red Valve Company, Inc.
 - k. Senior Flexonics, Inc.; Pathway Division.
 - l. Tozen America Corp.
 - m. Unaflex Inc.
 - n. Vibration Mountings & Controls, Inc.
 2. Arch Type: Multiple arches.
 3. Spherical Type: Multiple spheres.

- a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
 - b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.
 - c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.
 - 4. Material: Buna-N or EPDM.
 - 5. End Connections: Full-faced, integral, steel flanges with steel retaining rings.
- D. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
- 1. Manufacturers:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex-Pression, Ltd.
 - d. Metraflex, Inc.
 - 2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.
 - a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - 3. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.
 - a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
 - 4. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
 - a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
 - 5. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
 - a. NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

- b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- c. NPS 8 and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

2.2 ALIGNMENT GUIDES

- A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

1. Manufacturers:

- a. Adscro Manufacturing, LLC.
- b. Advanced Thermal Systems, Inc.
- c. Flex-Hose Co., Inc.
- d. Flexicraft Industries.
- e. Flex-Weld, Inc.
- f. Hyspan Precision Products, Inc.
- g. Metraflex, Inc.
- h. Piping Technology & Products, Inc.
- i. Senior Flexonics, Inc.; Pathway Division.

2.3 MATERIALS FOR ANCHORS

- A. Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Stud: Threaded, zinc-coated carbon steel.
 - 2. Expansion Plug: Zinc-coated steel.
 - 3. Washer and Nut: Zinc-coated steel.
- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - 3. Washer and Nut: Zinc-coated steel.
- F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.
- G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

- A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
- B. Install expansion joints of sizes matching size of piping in which they are installed.
- C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

- A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Attach pipe bends and loops to anchors.
 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.
- E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION

SECTION 230519
METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gauges.
3. Test plugs.

B. Related Sections:

1. Division 23 Section "Steam and Condensate Heating Piping" for steam and condensate meters.
2. Division 23 Section "Facility Natural-Gas Piping" for gas meters.

1.2 DEFINITIONS

- A. CR:** Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM:** Ethylene propylene diene monomer rubber.

1.3 ACTION SUBMITTALS

- A. Product Data:** For each type of product indicated; include performance curves.
- B. Wiring Diagrams:** For power, signal, and control wiring.
- C. Shop Drawings:** Schedule for thermometers, gauges, and flowmeters indicating manufacturer's number, scale range, and location for each.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates:** For each type of thermometer, gauge, and flowmeters signed by product manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. A. Operation and Maintenance Data:** For meters and gauges to include in operation and maintenance manuals.

1.6 EXTRA MATERIALS

- A. Provide a PT measurement kit with thermometers and gauges chosen to indicate system pressures and temperatures at mid-scale. Provide multiple of each as mid-scale measurement dictates.

PART 2 - PRODUCTS

2.1 THERMOMETERS

- A. Digital Vari-angle Thermometer, self-powered and within 1% accuracy, Similar to Weiss Model DVU35.
 - 1. Case: Hi-impact ABS
 - 2. Range: -40/300 °F (-40/150 °C)
 - 3. Display: 3/8" LCD digits, wide ambient formula
 - 4. Accuracy: 1% of reading or 1° whichever is greater
 - 5. Resolution: 1/10° between -19.9/199.9 °F (-28/93 °C)
 - 6. Recalibration: Internal potentiometer
 - 7. Lux Rating: 10 Lux (one foot-candle)
 - 8. Update Rate: 10 seconds
 - 9. Ambient Operating Range: -30/140 °F (-35/60 °C)
 - 10. Ambient Temp. Error: Zero
 - 11. Humidity: 100%
 - 12. Sensor: Glass passivated thermistor
 - 13. Connector: Adjustable Angle

2.2 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type 304 Stainless Steel fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Ernst Gauge Co.
 - 2. Miljoco Corp.
 - 3. Trerice, H. O. Co.
 - 4. Weiss Instruments, Inc.
 - 5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
 - 6. Dwyer Instruments, Inc.
- B. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Liquid-filled type, cast aluminum, 4-1/2-inch diameter.
 - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.

3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or Black metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade B, plus or minus 1/2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 50 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or Black metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 0 to 50 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

D. Pressure-Gauge Fittings:

1. Valves: NPS 1/4 brass or stainless-steel ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.

2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install digital thermometers in the following locations:
 1. Inlet and outlet of each hydronic zone.
 2. Inlet and outlet of each hydronic boiler and chiller.
 3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
 4. Inlet and outlet of each hydronic heat exchanger.
- B. Install thermometers in separable sockets at each additional location indicated on the Drawings or specified elsewhere herein, and/or as a standard.
- C. Provide the following temperature ranges for thermometers, unless otherwise indicated:
 1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions
 2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
 3. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
 4. Steam and Condensate: 50 to 400 deg F, with 5-degree scale divisions.

3.2 GAUGE COCK APPLICATIONS

- A. Install test plugs adjacent to all control sensors (except Insertion Type Flow Meters) installed in piping systems.
- B. Valved pressure gauge connections shall be installed in each location indicated on the Drawings and/or specified elsewhere herein.
- C. Install each gauge cock on a nipple of sufficient length so that the cock handle will be free of the pipe insulation. Position each cock so that a 4-1/2" diameter dial gauge may be easily read and screwed into and out of the cock.
- D. On pumps use a single pressure gauge connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable.
- E. Install gauge cocks at each pump as close to pump suction and discharge connections as practicable. Use any gauge connections provided in the pump casing.

3.3 GAUGE APPLICATIONS

- A. Install dry-case-type pressure gauges at the following locations:
 1. Discharge of each pressure-reducing valve.
 2. At each steam connection to a heat exchanger in the mechanical equipment rooms.
- B. Install liquid-filled-case-type pressure gauges at chilled- and condenser-water inlets and outlets of chillers.

- C. On pumps use a single pressure gauge connected by ball valves and metal tubing to the inlet and discharge flanges as well as the suction diffuser inlet flange, if applicable.
- D. Furnish and install calibrated pressure gauges at each location indicated on the Drawings, specified elsewhere herein, and/or as a standard.

3.4 INSTALLATIONS

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated. Install thermowells using thermally conductive grease.
- C. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
- D. Install ball-valve and snubber or syphon fitting in piping for each pressure gauge for fluids (except steam).
- E. Install needle-valve and siphon fitting in piping for each pressure gauge for steam.
- F. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
- G. Install flowmeter elements in accessible positions in piping systems.
- H. Install flowmeter elements with at least (10) pipe diameters minimum straight lengths of pipe upstream and (5) pipe diameters downstream from element as prescribed by manufacturer's written instructions.
- I. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils, as indicated.
- J. Install test plugs adjacent to all gauges and control sensors (except insertion type flow meters) installed in piping systems.

3.5 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance for meters, gauges, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Install test plugs adjacent to the temperature sensing device used for controls for simultaneous reading with test instrument for calibration purposes.

3.6 ADJUSTING

- A. Calibrate meters according to manufacturer's written instructions, after installation.

END OF SECTION

SECTION 230523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following general-duty valves:

1. Bronze angle valves.
2. Cast-iron angle valves.
3. Copper-alloy ball valves.
4. Ferrous-alloy ball valves.
5. Ductile-iron butterfly valves.
6. High-pressure butterfly valves.
7. Bronze check valves.
8. Cast-iron swing check valves.
9. Spring-loaded, lift-disc check valves.
10. Bronze gate valves.
11. Cast-iron gate valves.
12. Bronze globe valves.
13. Cast-iron globe valves.
14. Cast-iron plug valves.
15. Resilient-seated, cast-iron, eccentric plug valves.
16. Chainwheel actuators.

B. Related Sections include the following:

1. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
2. Division 23 Sections for specialty valves applicable to specific services only.
3. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and charts.
4. Division 23 Section "Instrumentation and Control for HVAC" for actuators in control valve applications.
5. Division 23 Section "Hydronic Piping" for additional valves and fittings.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. HPS: High-pressure Steam. Any system pressure above 15 psig is HPS.
- D. LPS: Low-pressure Steam. Any system pressure less than or equal to 15 psig is LPS.
- E. NRS: Nonrising stem.
- F. OS&Y: Outside screw and yoke.

- G. PTFE: Polytetrafluoroethylene plastic.
- H. Single Flange: Any valve design where lugs are evenly spaced around the circumference of the valve face and attach to adjoining piping using full length bolts.
- I. Spring-loaded, Lift-disc Check Valve: Non-slam check valve.
- J. SWP: Steam working pressure.
- K. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body the following:

1. Seating, and trim materials
2. Valve design
3. Pressure and temperature classifications
4. End connections
5. Arrangement
6. Dimensions
7. Required clearances.
8. Include list indicating valve and its application by system and size.
9. Include rated capacities
10. Shipping, installed, and operating weights
11. Furnished specialties
12. Accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each valve include operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle, gate, and globe valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.

- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Copper-alloy Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated. All valves shall comply with recognized industry standards such as MSS SP-80 and SP-110.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
 - 2. Gear Drive: Enclosed worm gear.
 - 3. Handwheel: For valves other than quarter-turn types.
 - 4. Lever Handle: Clamp lock.
 - 5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
- G. Valves in Insulated Piping: Valves shall have 3-inch stem extensions and the following features:
 - 1. Gate Valves: Shall be rising-stem type.
 - 2. Ball Valves: Shall have extended operating handle of non-thermal-conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. Jamesbury, Inc.
 - c. Kitz Insulated Stem Extension Model #ISE 1 thru 4
 - d. NIBCO Nib-seal handle extension
 - 3. Butterfly Valves: Shall have extended necks.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

- I. Valve Grooved Ends: AWWA C606.
- J. Solder Joint: With sockets according to ASME B16.18.
 - 1. Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
- K. Threaded: With threads according to ASME B1.20.1.
- L. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

- A. Bronze Angle Valves, General: MSS SP-80, with silicon bronze stem, non-asbestos packing and malleable-iron handwheel.
- B. Class 150, Bronze Angle Valves: ASTM B 62 bronze body with TFE disc, union-ring bonnet, threaded ends, and having 300-psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. NIBCO Model T-335-Y
 - 3. Powell, Wm. Co.
- C. Class 300, Bronze Angle Valves with Stainless-Steel Disc: ASTM B 61 bronze body with stainless-steel plug and renewable seat, union-ring bonnet, threaded ends, and having 600-psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. NIBCO Model T-376-AP
 - 3. Powell, Wm. Co.

2.3 CAST-IRON ANGLE VALVES

- A. Cast-Iron Angle Valves, General: MSS SP-85, Type II; having ASTM A 126, Class B cast-iron body and bolted bonnet; bronze mounted, non-asbestos packing and gaskets; and flanged-end connections.
- B. Class 125, Cast-Iron, Standard Angle Valves: 200-psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. NIBCO Model F-818-B
 - 3. Powell, Wm. Co.
- C. Class 250, Cast-Iron, Stop-Check Angle Valves: Stop-check design with non-asbestos packing and gaskets, and having 500-psig (3450-kPa) CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. NIBCO Model NIBCO Model F-869-B
 - 3. Powell, Wm. Co.

2.4 COPPER ALLOY BALL VALVES

- A. Brass Ball Valves, General: MSS SP-110 and have a brass body complying with ASTM B 283.
- B. Bronze Ball Valves, General: MSS SP-110 and have a copper alloy body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.
- C. Two-Piece, Full-Port, Copper Alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, reinforced TFE seats, threaded body packnut design, blow-out proof stems, with adjustable stem packing, soldered or threaded ends; 150 psig SWP and 600-psig CWP ratings.
 - 1. Conbraco Industries, Inc.; Apollo Div.
 - 2. Jamesbury, Inc.
 - 3. Kitz Model #68M or #69M
 - 4. NIBCO Model S-585-70-66 or T-585-70-66
- D. Two-Piece, Full-Port, 250 psig SWP, Copper Alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, carbon-filled TFE seats, threaded body packnut design, blow-out proof stems, with adjustable stem packing, threaded ends; 250 psig SWP and 600-psig CWP ratings.
 - 1. Conbraco Industries, Inc.; Apollo Div.
 - 2. Jamesbury, Inc.
 - 3. Kitz Model #68PM
 - 4. NIBCO Model T-585-70-66-ST
- E. Three-Piece, Full Port, Copper Alloy Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel vented ball and stem, threaded body packnut, blow-out proof stems, with adjustable stem packing, stainless nuts and bolts on valve body, soldered or threaded ends; 150 psig SWP and 600-psig CWP rating.
 - 1. Conbraco Industries, Inc.; Apollo Div.
 - 2. Jamesbury, Inc.
 - 3. Kitz Model #62M or #63M
 - 4. NIBCO Model S-595-Y-66-SS or T-595-Y-66-SS

2.5 FERROUS-ALLOY BALL VALVES

- A. Ferrous-Alloy Ball Valves, General: MSS SP-72, with ASTM A-216 Type WCB, carbon-steel body; ASTM A-351, Type CF8M vented stainless-steel ball; and ASTM A-276, Type 316 stainless-steel stem; fire rated according to API 607 (4th edition); and having flanged ends and blowout-proof stem.
- B. Class 150, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 285 psig CWP rating.
 - 1. Conbraco Industries, Inc.; Apollo Div.
 - 2. Jamesbury, Inc.
 - 3. Kitz 150SCTDZM-FS BZM-FS(C)
 - 4. NIBCO Model F-515-CS-F-66-FS

- C. Class 300, Full-Port, Ferrous-Alloy Ball Valves: Split-body construction, carbon-filled TFE seats; 720 psig CWP rating.

1. Conbraco Industries, Inc.; Apollo Div.
2. Jamesbury, Inc.
3. Kitz 300SCTDZM-FS BZM-FS(C)
4. NIBCO Model F-535-CS-F-66-FS

2.6 FERROUS-ALLOY BUTTERFLY VALVES

- A. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, grooved and flanged valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange. Valves NPS 12 and smaller shall not have exposed stem to disc fasteners and no exterior mounted fasteners to hold the liner.
2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.

- B. Single-Flange, 150-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece Type 416 stainless-steel stem, bronze bushing, aluminum-bronze disc, and phenolic-backed EPDM seat (liner) attached to the body.

1. Cooper Cameron Corp.; Cooper Cameron Valves Div.
2. DeZURIK; SPX Corporation
3. Kitz Model #6123EG
4. NIBCO Model LD-1000-5

- C. Single-Flange, 200-psig CWP Rating, Aluminum-Bronze Disc, EPDM Seat, Ferrous-Alloy Butterfly Valves: Full-lug type with ductile-iron body, one- or two-piece, Type 410 or 416 stainless-steel stem, copper bushing, fasteners and pins shall not be used to attach stem, to disc, no pins or fasteners in waterway, aluminum-bronze disc, and molded-in EPDM seat (liner).

1. Cooper Cameron Corp.; Cooper Cameron Valves Div.
2. DeZURIK; SPX Corporation
3. Kitz Model #6123EL or #6123EG
4. NIBCO Model LD-2000-3/5

- D. Grooved-End, Ferrous-Alloy Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Ductile-iron with grooved or shouldered ends, polyamide coating inside and outside, two-piece Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, fasteners and pins shall not be used to attach stem to disc, no pins or fasteners in waterway, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Anvil International, Inc.
2. Grinnell Mechanical Products.
3. NIBCO Model GD-4765-3/5
4. Victaulic Co. of America.

2.7 HIGH-PRESSURE BUTTERFLY VALVES

- A. High-Pressure Butterfly Valves, General: MSS SP-68 API 609 seat pressure and temperature ratings, ANSI B1634A body pressure and temperature ratings, ANSI B16.5 flange dimensions, ISO 5211, EN 12116 actuator mounting top works, capable of bi-directional dead-end service at full-rated pressure without use of downstream flange, carbon-steel body, offset design, extended-neck for insulation, permanently lubricated 300-series stainless-steel bushings with graphite and modified PTFE seats, graphite packing and gasket, one-piece duplex stainless-steel stem, and stainless-steel disc. Maximum steam rating of 50 psig. Valves NPS 6 and smaller shall have lever-lock operator; valves NPS 8 and larger shall have weatherproof gear operator.
- B. Single-Flange, Full-Lug, 285 psig CWP Rating, High-Pressure Butterfly Valves:
 - 1. Jamesbury, Inc.
 - 2. NIBCO Model LCS6822-3/5
 - 3. Xomox Corporation.
- C. Single-Flange, Full-Lug, 720 psig CWP Rating, High-Pressure Butterfly Valves:
 - 1. Jamesbury, Inc.
 - 2. NIBCO Model LCS7822-3/5
 - 3. Xomox Corporation.

2.8 BRONZE CHECK VALVES

- A. Bronze Check Valves, General: MSS SP-80.
- B. Class 125, Bronze, Lift Check Valves with TFE Disc: ASTM B-584 bronze body and integral seat with soldered or threaded end connections, and having 250-psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Kitz Model #26 or #36
 - 3. NIBCO Model S-480-Y or T-480-Y
 - 4. Powell, Wm. Co.
- C. Class 125, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 200 psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Kitz Model #23T or #22T
 - 3. NIBCO Model S-413-Y or T-413-Y
 - 4. Powell, Wm. Co.
- D. Class 150, Bronze, Swing Check Valves with TFE Disc: ASTM B-62 bronze body and seat with TFE disc in bronze seat holder, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Kitz #30T or #29T
 - 3. NIBCO Model S-433-Y or T-433-Y
 - 4. Powell, Wm. Co.

- E. Class 300, Bronze, Swing Check Valves with Bronze Disc: ASTM B-61 bronze body and seat with regrinding-type bronze disc, Y-pattern design, threaded end connections, and having 600 psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Kitz Model #19
 - 3. NIBCO Model T-473-B
 - 4. Powell, Wm. Co.

2.9 IRON SWING CHECK VALVES

- A. Iron Swing Check Valves, General: MSS SP-71.
- B. Class 125, Gray-Iron, Standard Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; bronze disc and seat; and having 200 psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Kitz Model #78
 - 3. NIBCO Model F-918-B
 - 4. Powell, Wm. Co.
- C. Class 250, Gray-Iron, Swing Check Valves: ASTM A-126, Class B cast-iron body and bolted bonnet with flanged end connections; non-asbestos synthetic-fiber gaskets; and bronze disc and seat; and having 500 psig CWP rating.
 - 1. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. NIBCO Model F-968-B
 - 3. Powell, Wm. Co.
- D. Grooved-End, Swing Check Valves: Ductile-iron body with grooved or shouldered ends; nonasbestos, synthetic-fiber gaskets; rubber seats; and having 250-psig CWP Rating.
 - 1. Anvil International, Inc.
 - 2. Grinnell Mechanical Products
 - 3. NIBCO Model G-917-W
 - 4. Victaulic Co. of America

2.10 SPRING-LOADED, CENTER-GUIDED LIFT-DISC, IRON CHECK VALVES

- A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.
- B. Class 125, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 200 psig CWP rating.
 - 1. NIBCO Model F-910-B
 - 2. Kitz #7022 (wafer)
 - 3. Metraflex Co.
 - 4. Val-Matic Valve & Mfg. Corp.
- C. Class 250, Globe, Flanged Lift-Disc Check Valves: Globe style with cast-iron body and flanged ends, and having 400 psig CWP rating.

1. NIBCO Model F-960-B
2. Metraflex Co.
3. Val-Matic Valve & Mfg. Corp.

2.11 BRONZE GATE VALVES

- A. Bronze Gate Valves, General: MSS SP-80, with malleable-iron handwheel.
- B. Class 150, Rising-Stem, Union-Ring Bonnet, Bronze Gate Valves: ASTM B-62 bronze body, bonnet, and wedge, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.
 1. Crane Co.; Crane Valve Group; Crane Valves.
 2. Kitz Model #43 or #42T
 3. NIBCO Model S-134 or T-134
 4. Powell, Wm. Co.
- C. Class 300, Rising-Stem, Stainless-Steel Wedge, Bronze Gate Valves: ASTM B-61 bronze body, bonnet and seat, stainless-steel wedge and seat, copper-silicone bronze stem, union-ring bonnet, and threaded end connections; and having 600 psig CWP rating.
 1. Crane Co.; Crane Valve Group; Crane Valves.
 2. NIBCO Model T-174-SS
 3. Powell, Wm. Co.

2.12 CAST-IRON GATE VALVES

- A. Cast-Iron Gate Valves, General: MSS SP-70, Type I with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.
- B. Class 125, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim, and solid-wedge disc; and having 200 psig CWP rating.
 1. Crane Co.; Crane Valve Group; Crane Valves.
 2. Kitz Model #72
 3. NIBCO Model F-617-O
 4. Powell, Wm. Co.
- C. Class 250, OS&Y, Bronze-Mounted, Cast-Iron Gate Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim, and solid-wedge disc; and having 500 psig CWP rating.
 1. Crane Co.; Crane Valve Group; Crane Valves.
 2. NIBCO Model F-667-O
 3. Powell, Wm. Co.

2.13 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, General: MSS SP-80, with malleable-iron handwheel.
- B. Class 150, TFE Disc, Bronze Globe Valves: ASTM B-62 bronze body, bonnet, and seat, TFE disc, copper-silicone bronze stem, union-ring bonnet, soldered or threaded end connections; and having 300 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #10 or #9
3. NIBCO Model S-235-Y or T-235-Y
4. Powell, Wm. Co.

- C. Class 300, Stainless-Steel Disc, Bronze Globe Valves: ASTM B-61 bronze body and bonnet, stainless-steel disc and seat, copper-silicone bronze stem, union-ring bonnet, threaded end connections; and having 600 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #17S
3. NIBCO Model T-276-AP
4. Powell, Wm. Co.

2.14 CAST-IRON GLOBE VALVES

- A. Cast-Iron Globe Valves, General: MSS SP-85 with bolted bonnet, flanged end connections, and non-asbestos packing and gasket.

- B. Class 125, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 200 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Kitz Model #76
3. NIBCO Model F-718-B
4. Powell, Wm. Co.

- C. Class 250, Metal Seat, Cast-Iron Globe Valves: ASTM A-126, Class B cast-iron body and bonnet with bronze trim and having 500 psig CWP rating.

1. Crane Co.; Crane Valve Group; Crane Valves.
2. NIBCO Model F-768-B
3. Powell, Wm. Co.

2.15 CAST-IRON PLUG VALVES

- A. Available Manufacturers:

1. Lubricated-Type, Cast-Iron Plug Valves:

- a. Milliken Valve Co., Inc.
- b. Nordstrom Valves, Inc.
- c. Olson Technologies; Homestead Div.
- d. R & M Energy Systems (Tomball, TX).
- e. Walworth Co.

2. Nonlubricated-Type, Cast-Iron Plug Valves:

- a. General Signal; DeZurik Unit.
- b. Grinnell Corporation.
- c. Mueller Flow Technologies.
- d. Tyco International, Ltd.; Tyco Valves & Controls.
- e. Wheatley Gaso, Inc.

f. Xomox Corporation.

- B. Cast-Iron Plug Valves, General: MSS SP-78.
- C. Class 125 or 150, lubricated-type, cast-iron plug valves.
- D. Class 250 or 300, lubricated-type, cast-iron plug valves.
- E. Class 125 or 150, nonlubricated-type, cast-iron plug valves.
- F. Class 250, nonlubricated-type, cast-iron plug valves.

2.16 RESILIENT-SEATED, CAST-IRON, ECCENTRIC PLUG VALVES

- A. Available Manufacturers:
 - 1. General Signal; DeZurik Unit.
 - 2. Milliken Valve Company.
 - 3. Olson Technologies; Homestead Div.
 - 4. Pratt, Henry Company.
 - 5. Val-Matic Valve & Mfg. Corp.
- B. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 2-1/2 and Smaller: Design similar to MSS SP-108, and rated for 175-psig minimum CWP.
- C. Resilient-Seated, Cast-Iron, Eccentric Plug Valves, NPS 3 and Larger: MSS SP-108, and rated for 175-psig minimum CWP.

2.17 CHAINWHEEL ACTUATORS

- A. Manufacturers:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries, Inc.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve
 - 2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 3. Chain: Hot-dip, galvanized steel of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Chilled-Water Piping:

1. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 to NPS 12: Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ductile iron.
4. Butterfly Valves, NPS 14: Single-flange, full lug, 150-psig CWP rating, bronze disc, EPDM liner, ductile iron.
5. Gate Valves, NPS 2 and Smaller: bronze body with extended stem, Class 200.
6. Gate Valves, NPS 2-1/2 and Larger: bronze body with extended stem, Class 200.
7. High-Pressure Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 285 psig CWP rating.
8. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 to NPS 8 300-psig CWP rating, EPDM- encapsulated ductile-iron disc.
9. Grooved-End, Ductile-Iron Butterfly Valves, NPS 10 to NPS 12: 200-psig CWP rating, EPDM- encapsulated ductile-iron disc.
10. Lift Check Valves, NPS 2 and Smaller: Class 125, non-slam type, bronze with TFE disc.
11. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze with TFE disc.
12. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, non-slam type, cast-iron, standard.
13. Grooved-End Swing Check Valves, NPS 2-1/2 and Larger: Grooved-end, ductile-iron, swing check valves.
14. Spring-Loaded, Center-Guided Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, flanged end, iron.
15. Plug Valves, NPS 2 and Larger: Class 125 or 150, nonlubricated-type, cast iron.
16. Resilient-Seated, Eccentric Plug Valves, NPS 3 and Larger: 175-psig CWP rating, cast iron.

B. Heating Water Piping:

1. Gate Valves, NPS 2 and Smaller: bronze body with extended stem, Class 150.
2. Gate Valves, NPS 2-1/2 and Larger: bronze body with extended stem, Class 150.
3. Butterfly Valves, NPS 2-1/2 to NPS 12 Single-flange, full lug, 200-psig CWP rating, bronze disc, EPDM liner, ductile iron.

4. Butterfly Valves, NPS 14: Single-flange, full lug, 150-psig CWP rating, bronze disc, EPDM liner, ductile iron.
5. High-Pressure Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 285 psig CWP rating.
6. Grooved-End, Ductile-Iron Butterfly Valves, NPS 2-1/2 to NPS 8: 300-psig CWP rating, EPDM- encapsulated ductile-iron disc.
7. Grooved-End, Ductile-Iron Butterfly Valves, NPS 10 to NPS 12: 200-psig CWP rating, EPDM- encapsulated ductile-iron disc.
8. Lift Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.
9. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze with TFE disc.
10. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, cast iron, standard.
11. Grooved-End Swing Check Valves, NPS 2-1/2 and Larger: Grooved-end, ductile-iron, swing check valves.
12. Spring-Loaded, Center-Guided, Lift-Disc Check Valves, NPS 2-1/2 and Larger: Class 125, flanged end, iron.

C. Steam Piping, 0 - 125 psig Operating Pressure:

1. Angle Valves, NPS 2 and Smaller: Class 150, with TFE disc, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Class 125, cast iron.
3. Ball Valves, NPS 2 and Smaller: Two -piece, full port, stainless-steel trim, bronze.
4. Ball Valves, NPS 2-1/2 and Larger: Class 150, full -port, ferrous alloy.
5. High-Pressure Butterfly Valves, NPS 2-1/2 and Larger: Single-flange 285 psig CWP rating.
6. Swing Check Valves, NPS 2 and Smaller: Class 125, bronze with TFE disc.
7. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, cast-iron, standard.
8. Gate Valves, NPS 2 and Smaller: Class 150, bronze.
9. Gate Valves, NPS 2-1/2 and Larger: Class 125, cast iron.
10. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, TFE disc, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Class 125; cast iron.

D. Steam Condensate Piping:

1. Angle Valves, NPS 2 and Smaller: Class 150, TFE disc, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Class 250, cast iron.
3. Ball Valves, NPS 2 and Smaller: Class 250, Two -piece, full port, stainless-steel trim, copper alloy.
4. Ball Valves, NPS 2-1/2 and Larger: Class 300, full -port, ferrous alloy.
5. High-Pressure Butterfly Valves, NPS 2-1/2 and Larger: Single-flange, 720 psig CWP rating.
6. Swing Check Valves, NPS 2 and Smaller: Class 300, bronze with bronze disc.
7. Swing Check Valves, NPS 2-1/2 and Larger: Class 250, gray iron, standard.
8. Gate Valves, NPS 2 and Smaller: Class 300, bronze.
9. Gate Valves, NPS 2-1/2 and Larger: Class 250, cast iron.
10. Globe Valves, NPS 2 and Smaller: Class 300, stainless-steel disc, bronze.
11. Globe Valves, NPS 2-1/2 and Larger: Class 250, cast iron.

E. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, for chilled or condenser water piping systems only.
2. For Copper Tubing, NPS 2-1/2 and Larger: Flanged ends.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends.
5. For Grooved-End, Copper Tubing and Steel Piping: Valve ends may be grooved. Do not use for steam or steam condensate piping.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. For shut-off service of hydronic systems, use
 - 1. Up to NPS 2: Gate type.
 - 2. NPS 2-1/2 and greater: Gate or Butterfly type.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. Install valves in position to allow full stem movement.
- G. Provide clamp lock lever handle for all valves, other than plug type, NPS 4 or smaller.
- H. Provide hand wheel for all valves, other than plug type, NPS 6 and greater.
- I. Install chainwheel operators on valves NPS 4 and larger and more than 78 inches above floor. Extend chains to 60 inches above finished floor elevation.
- J. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 5. Division 23 Sections "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.
 - 6. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.

1.2 DEFINITIONS

- A. MFMA: Metal Framing Manufacturers Association.
- B. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.
- C. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel", AWS D1.3, "Structural Welding Code--Sheet Steel", AWS D1.4, "Structural Welding Code--Reinforcing Steel", ASME Boiler and Pressure Vessel Code: Section IX as required.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.
- C. Pipe hangers and supports shall conform to the recommendations of ASHRAE, ASPE, ANSI, and MSS, unless otherwise indicated.
- D. Ensure anchors are acceptable per ICC for use in cracked concrete.
- E. Furnish and install hangers and supports that conform to the requirements of the following codes and standards:
 - 1. Metal Framing Manufacturers Association

- a. MFMA-4, Metal Framing Standards Publication.
- b. MFMA-103, Guidelines for the Use of Metal Framing.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Anvil.
 - 3. Bergen-Power Pipe Supports.
 - 4. B-Line Systems, Inc.; a division of Cooper Industries.
 - 5. Carpenter & Paterson, Inc.
 - 6. Empire Industries, Inc.
 - 7. ERICO/Michigan Hanger Co.
 - 8. Globe Pipe Hanger Products, Inc.
 - 9. Grinnell Corp.
 - 10. GS Metals Corp.
 - 11. National Pipe Hanger Corporation.
 - 12. PHD Manufacturing, Inc.
 - 13. PHS Industries, Inc.
 - 14. Piping Technology & Products, Inc.
 - 15. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.

5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type or threaded-anchor-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
- b. Empire Industries, Inc.
- c. Hilti, Inc.
- d. ITW Ramset/Red Head.
- e. MKT Fastening, LLC.
- f. Powers Fasteners.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.

6. Hanger Rods: Solid, threaded steel.

2.5 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:

- a. ERICO/Michigan Hanger Co.
- b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

- a. MIRO Industries.
- b. Portable Pipe Hangers.

- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

- a. ERICO/Michigan Hanger Co.
- b. MIRO Industries.
- c. Portable Pipe Hangers.

2. Base: Plastic or stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

- a. Portable Pipe Hangers.

2. Bases: One or more plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

1. Available Manufacturers:

- a. Curb Technologies.
- b. Pate.
- c. Thy Curb.

1) Models:

- a) TC-1 for insulated roof decks.
- b) TC-2 for un-insulated and existing roof decks.
- c) TC-3 for Bulb-T roof decks.

d. United Air

2. Pipe curbs and rails with covers shall be all welded 18 gauge galvanized steel shell and baseplate, wood nailer, and TP-1 Duro EPDM cover or TP-2 pipe cover, as detailed on the drawings, for pipe penetration(s).

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

1. Available Manufacturers:

- a. Curb Technologies.
- b. Pate.
- c. Thy Curb.

1) Models:

- a) TEMS-1 for insulated roof decks.
- b) TEMS-2 for un-insulated and existing roof decks.
- c) TEMS-3 for single-ply roof systems.

d. United Air

2. Equipment supports shall be all welded 18 gauge galvanized steel shell, baseplate and counterflashing with internal bulkhead re-enforcement and wood nailer.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to proper placement of inserts, anchors and other building structural attachments.

3.2 HANGER AND SUPPORT APPLICATIONS

- A. Use only one type hangers and supports, by one manufacturer, for each piping service.
- B. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- C. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- D. Use galvanized steel, painted, or cadmium plated components in hangers and supports unless otherwise indicated.

- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing or provide copper-plated hangers and supports for copper piping systems where hangers are in contact with bare pipe.
- F. Use padded hangers for piping that is subject to scratching.
- G. Horizontal-Piping Hangers and Supports: Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Slide and Slide Plate (MSS Type 35): For support of piping where horizontal movement due to expansion and contraction may occur, and where a low coefficient of friction is desired. Support system shall include guided plate mounted on a concrete pedestal or structural steel support.
 - 15. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 16. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 17. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 - 18. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 19. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 20. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

21. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 22. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- H. Vertical-Piping Clamps: Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Select size of hanger rod attachments to suit hanger rods. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- J. Building Attachments: Select size of building attachments to suit hanger rods. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- L. Spring Hangers and Supports: Select spring hangers and supports to suit pipe size and loading. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- M. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-58 and MSS SP-69 for construction standards and applications. Install hangers, supports, clamps, and attachments as required by the following table to properly support piping from building structure.

Pipe Size (in)	Max. Hanger Spacing (ft)	Min. Rod Size (in)	Max. Alternate Hanger Spacing (ft)	Min. Alternate Rod Size (in)
1/2	6	3/8	--	--
3/4	6	3/8	--	--
1	7	3/8	--	--
1-1/4	8	3/8	--	--
1-1/2	9	3/8	--	--
2	10	3/8	--	--
2-1/2	11	1/2	--	--
3	12	1/2	8	3/8
3-1/2	13	5/8	8	3/8
4	14	5/8	8	3/8
5	16	5/8	10	1/2
6	17	3/4	10	1/2
8	19	7/8	10	1/2
10	20	7/8	10	1/2
12	20	7/8	10	1/2
14	20	1	16	7/8
16	20	1-1/8	14	7/8
18	20	1-1/4	10	7/8
20	20	1-1/4	10	7/8
24	20	1-1/4	8	7/8

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricated from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
 3. Neither wire nor perforated metal shall be used to support piping, unless otherwise indicated or approved.
 4. Do not support piping from other piping, unless otherwise indicated.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with Division 23 Section "HVAC Insulation" and the following:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - b. Shield Dimensions for Pipe: Not less than the following:
 - 1) Pipes NPS 8 and Larger: Include wood inserts.
 - 2) Insert Material: Length at least as long as protective shield.
 - c. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports, as required, unless otherwise indicated.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1 inch.

3.7 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.8 TUNNEL SUPPORTS

- A. The tunnel piping shall be supported. Supports shall be a delegated design. The Mechanical Contractor shall coordinate with the General Contractor to insure that the proper steel supports are provided.
- B. Where systems leave a tunnel and enter grade, provide a coordinated, delegated design to ensure soil-borne forces and adequate cover are provided for direct buried systems.

3.9 THRUST BLOCKS

- A. Concrete thrust blocks as a part of a delegated design shall be installed at underground mechanical piping connections to prevent separation under pressure at the following locations:
 - 1. Changes in direction 22-1/2 deg. And greater (both horizontal and vertical).
 - 2. Terminal ends.
 - 3. All valves, so as to support the body weight and prevent excessive torque on pipe connections.
- B. Each thrust block shall be sized to accommodate the piping and soil conditions.
- C. Thrust blocks:
 - 1. Provide concrete thrust blocks at all changes in direction of piping of non-restrained mechanical jointed pressure systems and other systems as required.
 - a. Provide thrust blocks for restrained mechanical jointed piping systems where indicated.
 - 2. Provide 3,000 psi minimum concrete mix.
 - 3. Provide thrust blocks of the required size and shape necessary for the specific system pressure and soil bearing capacity at the particular location.
 - 4. Exercise Care to avoid encasing fittings, bends, valves, etc., in concrete to the extent that it will hamper maintenance.

3.10 SECURING UNDERGROUND LINES

- A. Install pipe clamps and braces using poured in place concrete blocks, or other anchors and supports required to insure stability of all underground lines to prevent joint separation either during tests or thereafter when lines are in service. Provide a delegated design for this application.
- B. Pipe Braces and nuts installed in the ground shall be fabricated of stainless steel to resist corrosion.

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SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Delegated Design requirements for system design.
2. Requirements for Manufacturer Seismic Certification.
3. Isolation pads.
4. Freestanding and restrained spring isolators.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restrained vibration isolation roof-curb rails.
11. Seismic snubbers.
12. Restraining braces and cables.
13. Steel and inertia, vibration isolation equipment bases.

B. Related Sections:

1. Division 23 Section "Common Work Results" for description of concrete bases used as vibration isolation.
2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for installation locations of pipe saddles at pipe hangers.

1.2 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. Seismic Certification: Seismic certification refers to a manufacturer's certification for architectural, mechanical, and electrical components, supports, and attachments pursuant to ASCE/SEI 7-05 Section 13.2.1.2.

D. Seismic Qualification: Same as Special Seismic Certification

E. Special Seismic Certification: Seismic certification of mechanical and electrical equipment based on ASCE/SEI 7-05 Section 13.2.2. Special Seismic Certification is required for active mechanical and electrical equipment that must remain operable following the design earthquake.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for vibration and seismic controls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Do not use more than one pre-approved seismic-force resistance system on any single run of pipe, duct or conduit. Mixing of multiple pre-approved systems is not acceptable.
- B. Seismic-Restraint Loading: In preparation of Delegated Design, utilize seismic forces as described in ASCE 7-02 "Minimum Design Loads for Buildings and Other Structures" as published by the American Society of Civil Engineers, unless requirements in this Section are more stringent.
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: As defined by ASCE 7-10 Section 13.1.3.
 - b. Assign component factors based on ASCE-7 Table 13.6-1 for the following:
 - 1) Component Response Modification Factor.
 - 2) Component Amplification Factor.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.138g.
 - 4. Design Spectral Response Acceleration at 1-Second Period: 0.088g.
- C. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 120 mph.
 - 2. Building Classification Category: III.
 - 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- D. Submittal Review Conference: At time of Delegated Design Shop Drawing submission, schedule a submittal review conference with the Architect and Structural Engineer-of-Record for the project. The purpose of this conference is to review attachment locations and insure supplementary framing that is needed to resist the loads, maintain stability or to meet other installation requirements of a pre-approved system have been accounted for in the Structural Engineer-of-Record's design.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 23 Section "Common Work Results for HVAC" for products specified under PART 2 – PRODUCTS.
- B. General Submittal Requirements:
 - 1. Submittals shall be reviewed by Architect and the Structural Engineer-of-Record prior to submitting them to authorities having jurisdiction.

C. Contractor Statement of Responsibility:

1. Submit a written statement in accordance with IBC Chapter 17.
2. Statement shall be submitted on company letterhead.
3. In instances where trade sub-contractors are responsible for construction and implementation of seismic-force resisting systems, the representatives of these various trade sub-contractors shall sign the Contractor Statement of Responsibility.

D. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

E. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
5. Field-fabricated supports.
6. Seismic- and Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
- c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
- d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

- 1. Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- 2. Submit approval from Structural Engineer where supports are directly connected to structure.

B. Welding certificates.

C. Common Requirements For Qualification Data:

- 1. Manufacturer Seismic Qualification Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in this Section. Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- 2. Manufacturer Special Seismic Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in this Section. Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For professional engineer and testing agency.
- E. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
- F. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For seismic-force restraint systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Copy of the Delegated Design Shop Drawings, including AHJ approval stamp.
 - 2. Copy of the Delegated Design Submittal, including AHJ approval stamp.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC, unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Special Seismic Certification: Unless otherwise allowed by OSHPD, mechanical components, supports, and attachments shall be certified pursuant to ASCE/SEI 7-05 Section 13.2.2. Items requiring certification are as follows, but not limited to:
 - 1. Components with hazardous contents, excluding pipes and ducts.
 - 2. Smoke control fans.
 - 3. Built-up or field assembled equipment.
 - 4. Air handling and air conditioning units.
 - 5. HVAC chillers.

6. Cooling Towers.
 7. Control panels.
- F. Rugged Equipment: Factory assembled, discrete components are considered rugged and deemed to comply with ASCE/SEI 7-05 Section 13.2.6, and do not require Special Seismic Certification, unless otherwise indicated by OSHPD. Items considered exempt are as follows:
1. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE/SEI 7-05, as modified by Section 1614A, 2007 CBC.
- G. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Vibration Isolation and Control

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. ISAT
4. Kinetics Noise Control.
5. Korfund Company.
6. Mason Industries.
7. Vibro-Acoustics

B. Seismic Restraint

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.
4. Hyspan.
5. ISAT
6. Kinetics Noise Control.
7. Korfund Company.
8. Mason Industries.
9. TOLCO Incorporated.
10. Unistrut; Tyco International, Ltd.
11. Vibro-Acoustics

2.2 VIBRATION ISOLATORS

- A. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Base plates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to base plate underside. Base plates shall limit floor load to 100 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled base plate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to base plate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- D. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- E. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- F. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- G. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- H. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.3 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

- A. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- B. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- C. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind restraint.
 - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Minimum Lateral Stiffness: $K_x/K_y = 1.0$.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 2. Pads: Oil and water resistant neoprene arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.
- D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.4 VIBRATION ISOLATION EQUIPMENT BASES

- A. Housekeeping Pads: Reinforced concrete 4" or 6" tall with 1" chamfer on all top edges.
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - b. The weight of each inertial block shall not be less than 150% of supported equipment.
 - c. Extend block minimum 4" beyond equipment base.
 - d. Chamfer edges minimum 1".

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Channels shall be minimum 6" deep. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.5 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener:
 1. Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
 2. Reinforcing steel angle clamped to hanger rod.
- F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

2.6 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Base: None.
 1. Suspended Equipment:
 - a. Fan Coil Units.
 - b. Piping in Mechanical Rooms, up to 3" NPS.
 2. Isolator: Spring hanger with 1" deflection.
- B. Base: None.
 1. Suspended Equipment:
 - a. Fan Systems:
 - 1) Axial Fans.
 - 2) Centrifugal, in-line Fans.
 - 3) Factory Fabricated AHUs.

- a) Provide structural steel channel to support unit and suspend frame from structure.
 - b) Piping in Mechanical Rooms, greater than 3" NPS.
 - 2. Isolator: Spring hanger with 2" deflection.
- C. Base: Roof Curbs or Rails.
 - 1. Equipment:
 - a. Roof Exhaust Fans.
 - b. Air Cooled Condensing Units.
 - c. Factory Fabricated AHUs without internal isolation.
 - 2. Isolator:
 - a. Pad integral with curb.
 - b. Restrained, open spring type with 1" deflection.
- D. Base: Reinforced Concrete Inertia Block
 - 1. Equipment: Pumping Systems
 - a. Fire.
 - b. Heating water.
 - 2. Isolator: Freestanding, open spring type with 1.5" deflection.
- E. Base: 4" Housekeeping Pad
 - 1. Equipment:
 - a. Floor mounted Fan Systems.
 - 1) Cabinet fans.
 - 2) Centrifugal fans:
 - a) DWDI.
 - b) In-line.
 - c) Utility vent sets.
 - 3) Factory Fabricated AHUs.
 - b. Floor mounted Reciprocating Air Compressors.
 - 2. Isolator: Restrained, open spring type with 2" deflection.
- F. Miscellaneous Systems
 - 1. Factory Fabricated, Internally Isolated, AHUs.
 - a. Base:
 - 1) 6" Housekeeping pad.
 - 2) Factory fabricated, sound attenuating curb.

- b. Isolator: Pad.
- 2. Jockey Pump
 - a. Base: 6" housekeeping pad.
 - b. Isolator: None.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- C. Install seismic isolators and restraints as required by delegate design calculations.
- D. Install hanger rod stiffeners to prevent buckling of hanger rods due to seismic forces.
- E. Install spring isolators for the closest three hangers for all piping attached to rotating equipment.
- F. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- G. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- H. Install cables so they do not bend across edges of adjacent equipment or building structure.
- I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

N. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 IDENTIFICATION

A. Install brass identification tags at all seismic brace locations. Tags to include the following information:

1. Unique keyed identification number that corresponds to nomenclature used to mark location on shop drawings and calculations.
2. Specific G-force the system at that location is designed to resist.
3. Maximum brace reaction to the structure.
4. For Individually suspended items: Maximum conduit size.
5. For Trapeze or Multiple pipe hangers: Maximum pounds-per-lineal-foot.
6. For Suspended Equipment: Maximum weight of equipment.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- F. Prepare a report that identifies unit components and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.7 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

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SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.
 - 6. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, laminated phenolic with a black surface and white substrate for mechanical engraving, 1/16 inch minimum thickness, beveled edges, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number as directed by owner. Secondary lettering shall indicate date of installation.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- D. Punched plastic tape for labels is not acceptable.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch minimum thickness, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1 inch for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Labels shall conform to ANSI A13.1 and the following table:

Outside Diameter of Pipe or of Covering	Height of Letters
$\frac{3}{4}$ " to 1-1/4"	$\frac{1}{2}$ "
1-1/2" to 2"	$\frac{3}{4}$ "
2-1/2" to 6"	1-1/4"
8" to 10"	2-1/2"
Over 10"	3-1/2"

- B. Available Manufacturers: Seton, Brady, or Westline.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction. For steam systems, also include line pressure on label.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2.4 DUCT LABELS

- A. Material and Thickness: Multicolor, plastic labels having adhesive for attachment.
- B. Service:
 - 1. Non-hazardous
 - a. Supply
 - b. Return
 - c. Outside air
 - d. Relief
 - e. General Exhaust
 - 2. Hazardous
 - a. Isolation Exhaust
 - b. Nuclear Medicine Exhaust
 - c. Laboratory Exhaust
 - d. Pharmacy Exhaust
 - e. Other air streams as indicated
- C. Letter Color:
 - 1. Non-hazardous Service: Black
 - 2. Hazardous Service: Black
- D. Background Color:
 - 1. Non-hazardous Service: White
 - 2. Hazardous Service: Orange

- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content.
- G. Minimum Letter Size: 2-1/2 inch for name of service.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with minimum 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain and S-hook or beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 FIRE DAMPERS AND SMOKE DAMPERS

- A. Provide identification for all fire damper or smoke damper access openings.
- B. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel red unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.
- C. Labels
 - 1. A. Material and Thickness: Multilayer, multicolor, laminated phenolic with a red surface and white substrate for mechanical engraving, 1/16 inch (1.6 mm) minimum thickness, beveled edges, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Red.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1 inch (25.4 mm) for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

D. Fire Damper and Smoke Damper Stencil and Labels Contents

1. "FIRE DAMPER" or "SMOKE DAMPER" as appropriate for each device.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment using fasteners or adhesives.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding:
 1. Painting of piping is specified in Division 09 Section "High-Performance Coatings."
 2. Provide color coding of all pipe services, either paint or PVC wrap, in the following:
 - a. Boiler Rooms
 - b. Central Plants / Power Houses
 - c. Mechanical Rooms
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
 7. In no case shall a line enter or leave a room without being identified.

8. Secure identification markers to piping by firmly pressing markers in place, following removal of protective covering. Additionally secure by banding ends of markers in place using 1/2 inch wide aluminum bands of the type normally used to secure insulation in place.

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on the outermost surface of an installed air ducts system.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems except:
 1. Check valves
 2. Valves within factory-fabricated equipment.
 3. Shutoff valves directly adjacent to equipment
 4. Faucets
 5. Convenience and lawn-watering hose connections
 6. HVAC terminal devices
- B. Emergency shut-off valves: Provide permanent equipment label with minimum 1" high lettering. These valves include valves 2" and larger for the following services:
 1. Domestic cold water.
 2. Domestic hot water.
 3. Chilled water.
 4. Heating water.
 5. Steam.
 6. Steam condensate.
 7. Natural gas.
- C. Mark ceiling grid with colored marker in style and material as required by Owner indicating valve locations above ceiling.
- D. List tagged valves in a valve schedule and provide to Owner with floor plans indicating location.

3.6 FIRE DAMPER AND SMOKE DAMPER LABEL INSTALLATION

- A. Stencil the words "FIRE DAMPER", "FIRE-SMOKE DAMPER" or "SMOKE DAMPER" on access doors that are in sheet metal ducts. Ensure overspray of stencil medium is cleaned, removed, or covered from adjacent piping, walls, and as otherwise indicated.
- B. Install tags on access doors that are in walls or ceilings where such doors conceal fire damper access plates, or on the T-bars of removable ceilings immediately below the location of fire damper access openings above.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Hydronic Piping Systems:
 - a. Constant-flow systems.
 - b. Variable-flow systems.
 - 3. Steam systems.
 - 4. HVAC equipment quantitative-performance settings.
 - 5. Space pressurization testing and adjusting.
 - 6. Smoke-control systems testing and adjusting.
 - 7. Verifying that automatic control devices are functioning properly.
 - 8. Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.

- I. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- J. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
- K. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- L. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- M. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- N. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- O. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- P. TAB: Testing, adjusting, and balancing.
- Q. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- R. Test: A procedure to determine quantitative performance of systems or equipment.
- S. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review based on system readiness reports and pre-functional check lists.
- F. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

- G. Sample Report Forms: Submit two sets of sample TAB report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.
- I. Warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. The TAB firm shall be organized to provide independent professional testing and balancing services. The firm shall have a minimum of one (1) Professional Engineer licensed in the project's state, in good standing with the board and have a current registration.
- B. All personnel used on the job site shall be either TAB engineers or TAB technicians, who shall have been permanent, full-time employees of the Tab firm for a minimum of six (6) months prior to working on the project.
- C. Upon request, the TAB Firm shall submit the following to the Architect/Engineer and/or Owner for approval prior to commencing services:
 - 1. Name and biographical data of the Professional Engineer and all personnel to be assigned to this project.
 - 2. Proof of company operation for minimum of five (5) years.
- D. TAB Firm Qualifications: Engage a TAB firm certified by AABC.
- E. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: As a minimum, include the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
 - g. Coordinate submission of FMS sequence and schematics for review by TAB firm.
- F. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

- G. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- H. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems."
- I. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

- A. Notice: Provide minimum seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.
- C. The Contractor shall start up and test all materials and equipment which normally require testing. All piping, etc., shall be tested to meet code requirements or the specification requirements, whichever is the more stringent. All equipment shall operate a sufficient length of time at the Contractor's expense to prove to the Architect/Engineer and/or Owner that the equipment is free from mechanical defects, runs smoothly and quietly and performs satisfactorily to meet the requirements set forth in the mechanical plans and specifications.
- D. In order that all HVAC systems can be properly tested, adjusted and balanced, the Contractor shall operate the HVAC systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB, and shall further operate and pay all costs of operation during the TAB period. Operating expenses to be paid for by the Contractor will include, but not necessarily be limited to, the following:
 - 1. Utility costs; electrical, water, gas, etc.
 - 2. Personnel costs to start, operate and stop all HVAC equipment.
 - 3. All start-up labor and material costs.
 - 4. All maintenance costs.
 - 5. Water treatment.
- E. The plans and specifications have indicated valves, dampers and miscellaneous adjustment devices for the purpose of testing and balancing the HVAC systems to obtain optimum operating conditions. The Contractor shall install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as required.
- F. The Contractor shall provide and coordinate services to repair or replace any and all deficient items or conditions found before and during the TAB period.
- G. As a part of this Project Contract, the Contractor shall make any changes in the sheaves, belts, motors, dampers and valves or the addition of dampers and/or valves as required to correctly balance the HVAC systems as required at no additional cost.
- H. Provide sufficient time in Project Contract completion schedule to permit the completion of TAB services prior to Owner occupancy of the Project.

- I. The Contractor shall furnish without charge to the TAB Firm:
 1. One set of mechanical specifications and all addenda.
 2. All pertinent change orders.
 3. Complete set of mechanical plans with latest revisions.
 4. "As-installed" drawings.
 5. Approved control diagrams and submittals.
 6. Approved manufacturer's submittals for all HVAC equipment.

1.6 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements.
 1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 3. Based on examination of the Contract Documents, to recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine equipment for installation and for properly operating safety interlocks and controls.
- N. Examine control system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Prepare a TAB plan that includes strategies and step-by-step procedures.
- C. The Contractor shall complete system readiness checks, prepare system readiness reports, and prefunctional tests including the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. TAB firm shall coordinate with Contractor to gather all required system points and data without voiding manufacturers' warranties. Facility personnel and factory-authorized service representatives may also be required.
- B. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and this Section.
- C. Cut insulation, penetrate pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- D. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- E. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Provide a marked-up set of mechanical plans or "as-built" duct layouts of systems that includes numbering of each HVAC device that corresponds to the respective item in the TAB report.
- C. For variable-air-volume systems, develop a plan to simulate diversity.

- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.
- K. Check for proper sealing of air duct system.

3.5 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.

3.6 GENERAL PROCEDURES FOR DOMESTIC HOT WATER SYSTEMS

- A. Balance domestic hot water recirculation, to ensure proper flow through all mains and branches. Tune system until hot water is delivered to the most remote fixture within the allowable time as required by the AHJ.

3.7 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

- A. Pressure testing shall be limited to the following room types:
 - 1. Soiled / Decontamination.
- B. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

- C. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.
- D. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - 1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - 3. Test room pressurization first, then zones, and finish with building pressurization.
- E. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- F. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - 1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - 2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
 - 3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- G. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- H. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.8 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

- A. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary. Verify that windows and doors are closed and that applicable safing, gasket, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.
- C. Measure, adjust, and record airflow of each smoke-control system with all fans that are a part of the system operating as intended by the design.
- D. Measure, adjust, and record the airflow of each fan. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.
- E. After air balancing is complete, perform the following pressurization testing for each smoke-control zone in the system:

1. Verify the boundaries of each smoke-control zone.
2. With the HVAC systems in their normal mode of operation and smoke control not operating, measure and record the pressure difference across each smoke-control zone. Make measurements after closing doors that separate the zones. Make one measurement across each door. Clearly indicate the high and low pressure side of each door.
3. With the system operating in the smoke-control mode and with each zone in the smoke-control system activated, perform the following:
 - a. Measure and record the pressure difference across each door that separates the smoke zone from adjacent zones. Make measurements with doors that separate the smoke zone from the other zones closed. Clearly indicate the high and low pressure side of the door. Doors that have a tendency to open slightly due to the pressure difference should have one pressure measurement made while held closed and another measurement made with the door open.
 - b. Continue to activate each separate zoned smoke-control system and make pressure difference measurements.
 - c. After testing a smoke zone's smoke-control system, deactivate the HVAC systems involved and return them to their normal operating mode before activating another zone's smoke-control system.
 - d. Verify that controls necessary to prevent excessive pressure differences are functional.

F. Operational Tests:

1. Check the proper activation of each zoned smoke-control system in response to all means of activation, both automatic and manual.
2. Check automatic activation in response to fire alarm signals received from the building's fire alarm and detection system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zoned smoke-control system occurs.
3. TAB firm involvement shall provide air flow and pressure measurements and verification of HVAC equipment and EMS control activation when Smoke-Control system is activated by others.
4. Check and record the proper operation of fans, dampers, and related equipment as outlined below for each separate zone of the smoke-control system.
 - a. Fire zone in which a smoke-control system automatically activates.
 - b. Type of signal that activates a smoke-control system, such as pull station, sprinkler water flow, or smoke detector.
 - c. Smoke zone(s) where maximum mechanical exhaust to the outside is implemented and no supply air is provided.
 - d. Positive pressure smoke-control zone(s) where maximum air supply is implemented and no exhaust to the outside is provided.
 - e. Fan(s) "ON" as required to implement the smoke-control system. Multiple- or variable-speed fans should be further noted as "MAX. VOLUME" to verify that the intended control configuration is achieved.
 - f. Fan(s) "OFF" as required to implement the smoke-control system.
 - g. Damper(s) "OPEN" where maximum airflow must be achieved.
 - h. Damper(s) "CLOSED" where no airflow should take place.
 - i. Auxiliary functions to achieve the smoke-control system configuration such as changes or override of normal operating pressure and temperature-control set points.
 - j. If standby power is provided for the smoke-control system, test to verify that the system functions while operating under both normal and standby power.

- G. Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.
- H. Using the air flow and pressure measurements taken by the TAB firm, the Contractor shall prepare a complete report of observations, measurements, and deficiencies.

3.9 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures for systems with pneumatic components and device positions and correlate with airflow and water flow measurements.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. For pneumatic systems, check main control supply-air pressure and observe compressor and dryer operations.
- J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans:
 - a. Up to 5000 cfm: 0 to plus 10 percent.
 - b. Larger than 5000 cfm: 0 to plus 5 percent.
 - 2. Air Devices
 - a. Exhaust: 0 to -10 percent.
 - b. Return: +/-5 percent.
 - c. Supply: 0 to +10 percent.
 - 3. Hydronic Flow Rates
 - a. Pumps: 0 to +10 percent.
 - b. Equipment: 0 to +5 percent.

3.11 REPORTING

- A. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems. A single, PDF document with navigational bookmarks by section may be substituted for a manual binder.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer, type size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports varies from indicated values.
- E. Provide a marked-up set of mechanical plans or "as-built" layouts of systems that include numbering of each HVAC device that corresponds to the respective item in the TAB report.

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Filter condition.
 - g. Preheat coil static-pressure differential in inches wg.
 - h. Cooling coil static-pressure differential in inches wg.
 - i. Heating coil static-pressure differential in inches wg.
 - j. Outside airflow in cfm.
 - k. Return airflow in cfm.
 - l. Relief airflow in cfm (L/s).
 - m. Outside-air damper position.
 - n. Return-air damper position.
 - o. Relief-air damper position.
 - p. Fan drive settings including VFD settings and percentage of maximum pitch diameter.
 - q. Settings for supply-air static-pressure controller.

G. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outside-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

H. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btuh.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.

- d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btuh.
 - i. High-fire fuel input in Btuh.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btuh.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btuh.
- I. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btuh.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btuh.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- J. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Make and frame type and size.

- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
- g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System and air-handling unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F.
- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft..
- g. Indicated airflow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual airflow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

L. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Test apparatus used.
- d. Area served.
- e. Air-terminal-device make.
- f. Air-terminal-device number from system diagram.
- g. Air-terminal-device type and model number.
- h. Air-terminal-device size.
- i. Air-terminal-device effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary airflow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final airflow rate in cfm.
- f. Final velocity in fpm.

M. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.
- e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.

N. Compressor and Condenser Reports: Utilize chiller data display for some of the information below. Indicate which items are not available on the display panel and rely on data provided by manufacturer instead. For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Unit make and model number.
- d. Compressor make.
- e. Compressor model and serial numbers.
- f. Refrigerant weight in lb.
- g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):

- a. Inlet-duct static pressure in inches wg.
- b. Outlet-duct static pressure in inches wg.
- c. Entering-air, dry-bulb temperature in deg F.
- d. Leaving-air, dry-bulb temperature in deg F.
- e. Condenser entering-water temperature in deg F.
- f. Condenser leaving-water temperature in deg F.
- g. Condenser-water temperature differential in deg F.
- h. Condenser entering-water pressure in feet of head or psig.
- i. Condenser leaving-water pressure in feet of head or psig.
- j. Condenser-water pressure differential in feet of head or psig.
- k. Low-pressure-cutout set point in psig.
- l. High-pressure-cutout set point in psig.
- m. Suction pressure in psig.
- n. Suction temperature in deg F.
- o. Condenser refrigerant pressure in psig.
- p. Condenser refrigerant temperature in deg F.
- q. Oil pressure in psig.
- r. Oil temperature in deg F.

- s. Voltage at each connection.
 - t. Amperage for each phase.
 - u. Kilowatt input.
 - v. Crankcase heater kilowatt.
 - w. Number of fans.
 - x. Condenser fan rpm.
 - y. Condenser fan motor make, frame size, rpm, and horsepower.
 - z. Condenser fan motor voltage at each connection.
 - aa. Condenser fan motor amperage for each phase.
- O. Heat-Exchanger/Converter Test Reports: For steam and hot-water heat exchangers, include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and type.
 - e. Model and serial numbers.
 - f. Ratings.
 - 2. Steam Test Data (Indicated and Actual Values):
 - a. Inlet pressure in psig.
 - 3. Primary Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Entering-water pressure in feet of head or psig.
 - d. Water pressure differential in feet of head or psig.
 - e. Water flow rate in gpm.
 - 4. Secondary Water Test Data (Indicated and Actual Values):
 - a. Entering-water temperature in deg F.
 - b. Leaving-water temperature in deg F.
 - c. Entering-water pressure in feet of head or psig.
 - d. Water pressure differential in feet of head or psig.
 - e. Water flow rate in gpm.
- P. Pump Test Reports:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.

- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.
- l. Impeller size.

Q. Boiler Test Reports:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and type.
- e. Model and serial numbers.
- f. Fuel type and input in Btuh.
- g. Number of passes.
- h. Ignition type.
- i. Burner-control types.
- j. Voltage at each connection.
- k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):

- a. Operating pressure in psig.
- b. Operating temperature in deg F.
- c. Entering-water temperature in deg F.
- d. Leaving-water temperature in deg F.
- e. Number of safety valves and sizes in NPS.
- f. Safety valve settings in psig.
- g. High-limit setting in psig.
- h. Operating-control setting.
- i. High-fire set point.
- j. Low-fire set point.
- k. Voltage at each connection.
- l. Amperage for each phase.
- m. Draft fan voltage at each connection.
- n. Draft fan amperage for each phase.
- o. Manifold pressure in psig.

R. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.13 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
- 2. Randomly check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Measure sound levels at two locations.
 - e. Measure space pressure of at least 10 percent of locations.
 - f. Verify that balancing devices are marked with final balance position.
 - g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

- 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
- 2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
- 3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- 6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
- 7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

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SECTION 230700

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Fiberglass.
 - d. Flexible elastomeric.
 - e. Mineral or glass fiber.
 - f. Phenolic.
 - g. Polyolefin.
2. Fire-rated insulation systems.
3. Factory-applied jackets.
4. Field-applied cloths.
5. Field-applied jackets.
6. Adhesives.
7. Mastics.
8. Lagging adhesives.
9. Sealants.
10. Tapes.
11. Securements.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.
4. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for installation locations of pipe saddles at pipe hangers.
5. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.
6. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Calculations: For insulation submitted outside of the conductivity range per the "Minimum Pipe Insulation Thickness" Table for the application listed, submit thickness calculations.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the United States Department of Labor, Employment and Training Registered Apprenticeship Program.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fiberglass
 - 1. Johns-Manville.
 - 2. K-Flex.
 - 3. Knauf Fiberglass.
 - 4. Manson (Certain Teed).
 - 5. Owens-Corning.
 - 6. Pittsburg-Corning.
- B. Flexible Elastomeric
 - 1. Aeroflex / Aerocel EPDM
 - 2. Armacell / Armaflex
 - 3. RBX Industries / Rubatex
- C. Phenolic
 - 1. Polyguard Products
 - 2. Resolco / Insul-Phen
- D. Polyisocyanurate
 - 1. Dow / Trymer
- E. Polyolefin
 - 1. Nomaco/ IMCOA Imcolock

2.2 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- G. Cellular Glass: Inorganic, incombustible, cellular or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Board Insulation: ASTM C 552, Type IV.
 - 4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Fiberglass
 - 1. Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
 - 2. Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density.
 - 3. Duct liner, flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side to be black, unless otherwise indicated, and rated for 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion, or approved equal, specifically formulated to:
 - a. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with "0" growth rating.
 - b. Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems.

- I. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials with a built-in vapor barrier. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
- J. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- L. Mineral Wool: ASTM C 547; preformed, high temperature insulation; 'k' value of 0.35 at 300 degrees F.
- M. Phenolic:
 - 1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 - 2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 - 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 4. Factory-Applied Jacket: FSJ for all applications unless otherwise indicated.
- N. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.3 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. 3M; Fire Barrier Wrap Products.
 - d. Unifrax Corporation; FyreWrap.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.

- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 360 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 ADHESIVES

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide insulation adhesive and jacket manufacturer shall provide jacket adhesive.
- B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- C. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
- D. Cellular-Glass and Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
- E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.6 MASTICS

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide mastics.
- B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 360 deg F.
 - 3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 4. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

2.7 LAGGING ADHESIVES

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide lagging adhesives
- B. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 2. Service Temperature Range: Minus 50 to plus 360 deg F.
 3. Color: White.

2.8 SEALANTS

- A. Products: Subject to compliance with requirements, insulation manufacturer shall provide sealants
- B. Joint Sealants for Cellular-Glass, and Phenolic Products:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: Aluminum.
- D. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 4. Color: White.

2.9 INSULATING CEMENT

- A. ASTM C 195; hydraulic setting mineral fiber thermal insulating cement with dry density of no more than 38 lb/ft³ thermal conductivity of 0.96 at 400°F mean temperature, and service temperature to 1200°F.
- B. Acceptable manufacturers: RAMCO or approved equal.

2.10 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. PVDC Jackets
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 - b. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - c. for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - d. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 6. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.11 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.12 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by Architect.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, and mechanical joints.
5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.

- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. PVDC Jackets:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
2. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
3. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
4. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.13 TAPES

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 1. Avery Dennison Corporation, Specialty Tapes Division.
 2. Compac Corp.
 3. Ideal Tape Co., Inc., an American Bilrite Company.
 4. Venture Tape.
 5. Dow Chemical Company (The).
- B. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- C. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- D. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.
- E. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.
- F. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Width: 3 inches.
 - 2. Film Thickness: 4 mils.
 - 3. Adhesive Thickness: 1.5 mils.
 - 4. Elongation at Break: 145 percent.
 - 5. Tensile Strength: 55 lbf/inch in width.
- G. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Width: 3 inches.
 - 2. Film Thickness: 6 mils.
 - 3. Adhesive Thickness: 1.5 mils.
 - 4. Elongation at Break: 145 percent.
 - 5. Tensile Strength: 55 lbf/inch in width.

2.14 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
 - 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
- B. Insulation Pins and Hangers:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- 1) AGM Industries, Inc.
 - 2) GEMCO.
 - 3) Midwest Fasteners, Inc.
 - 4) Nelson Stud Welding.
2. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, minimum 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 4. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Match ductwork material, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Match ductwork material, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 6. Insulation-Retaining Washers: Self-locking washers 0.016-inch-thick, Match pin material, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.15 PIPE INSULATION HANGER SHIELDS

- A. Where hangers are placed outside the jackets of pipe insulation, provide shields or equivalent by Elcen Metal Products Company.
- B. Insulation and shields shall consist of a 360 degree insert of high-density, 100 psi, waterproof calcium silicate, encased in a 360 degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1-inch beyond sheet metal shield in each direction. Shield lengths and minimum sheet metal gauges shall be as directed below:

<u>PIPE SIZE</u>	<u>SHIELD LENGTH</u>	<u>MINIMUM GAUGE</u>
1/2" to 8"	12"	16
10" & Larger	22"	16

- C. Insulation and shields for Phenolic type insulation shall consist of a 360 degree insert of high-density (minimum 5 lbs/cu.ft.) phenolic insulation by the same manufacturer, encased in a 360 degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1-inch beyond sheet metal shield in each direction. Shield length and gauge per above table.
- D. Shields shall be Model A1000 – A9000, except for pipe roller applications and where pipe hanger spacing exceeds 10 feet, then provide Model CSX-CW.
- E. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.

2.16 PREMANUFACTURED COVERS

- A. Preformed manufactured PVC fitting covers with rigid one piece (half-shell) preformed rigid insulation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Materials shall be applied by a qualified insulation applicator/workman skilled in this trade. Insulation shall be installed in accordance with the manufacturers written instructions and in accordance with recognized industry standards. Mechanical fasteners shall be used whenever possible to assure permanent construction. Unsightly work shall be cause for rejection.
- B. Prior to installation of any insulation materials to ferrous piping systems, the piping surfaces shall be thoroughly cleaned of all mill scale, grease and dirt and passed pressure testing.
- C. Non-compressible insulation material shall be installed at hanger supports on cold piping to prevent damage to insulation and vapor barrier. All wet duct and pipe insulation shall be replaced.
- D. Insulation of cold surfaces shall be vapor-sealed to prevent condensation.
- E. Minimum thickness of insulation shall be as scheduled unless alternate thicknesses can be shown to meet energy performance and approved by the Engineer.
- F. Where piping system insulation is specified, cover valves, strainers, unions, flanges, and fittings with pre-manufactured valve and fitting covers.
- G. Install pipe insulation hanger shields.
- H. Extend piping insulation without interruption through walls, floors and similar piping penetrations, there shall be no exceptions.
- I. Duct insulation shall terminate at fire/smoke damper sleeves. A separate strip of insulation shall be provided around the sleeve and sealed at the wall.
- J. Miscellaneous Applications
 - 1. Refrigerant suction lines within air cooled condensing units, heat pumps and chillers.

- K. Unless indicated otherwise, insulate pipe and equipment that operates:
 - 1. 10 degrees or lower than ambient space temperature.
 - 2. 10 degrees or higher than ambient space temperature.
- L. All steam valves and regulators at and below an elevation of 7' - 0" A.F.F. shall be insulated with removable asbestos free insulation jackets with Velcro fasteners to allow easy installation and removal.

3.2 APPLICATION TYPES

A. Equipment

- E1: Cut insulation to fit contour of equipment, and secure by means of bands, stick-clips, weld-pins and lugs or adhesives as required for each individual piece of equipment. Provide vapor barrier and finish as required for each specific application. Provide new cold surfaces of pumps with accessible boxes that easily separate coincidental with parting line of evaporator heads and pump casings. Resulting insulation joints shall be covered with a self-sealing, vapor-barrier tape. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

B. Piping

- P1: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Seal with double tape self-sealing adhesives.
- P2: Butt insulation together and securely tape. Install factory-furnished laps at the butt joints. Neatly bevel and finish insulation where it terminates. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.
- P3: Same as P2, except install insulation over heat trace tape. Finish with metal jacket.

C. Ductwork

- D1: Apply fiberglass board insulation to ducts with mechanical fasteners such as stick-clips or weld-pins (with tape and mastic) spaced as required to install full pieces of board insulation. Space on 12" centers (maximum) on the bottom of each duct and plenum. Cover joints and seams in vapor barrier facings with 3" wide matching tape, or with vapor-barrier mastic reinforced with 3" glass mesh reinforcement. Provide an additional layer of insulation board where duct-standing seams exceed the insulation thickness. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.
- D2: Wrap flexible fiberglass insulation around ducts and secure. Additionally, ducts 24 inches wide and larger shall secure insulation with stick clips on 18" centers. Lap insulation a minimum of four (4) inches and seal with an approved vapor barrier mastic. Reinforce lap with a three (3) inch wide band of either glass mesh reinforcement or foil/vapor-barrier tape. Seal raw glass to duct where insulation terminates. Seal all laps and penetrations in vapor barrier jacket with an approved vapor barrier mastic.

3.3 INSULATION SCHEDULE KEYS

Insulation Types Key					
	Type	Maximum K Factor @ 75°F	Temp. Limit °F	Density Lb. Per Cubic Foot	Federal Spec. Compliance
1.	Calcium Silicate	0.38	1200	14	HH-I-523C
2.	Fiberglass (Rigid)	0.23	450	3	ASTM C 547 Type 1
3.	Fiberglass Flexible Duct Wrap	0.25	250	1.5	
4.	Foamed Glass (Cellular)	0.36	850	9	HH-I-1751/3A
5.	Foamed Plastic (Flexible)	0.25	220	5	HH-I-573
6.	High Temperature Fiberglass	0.23	850	3	HH-1-558B
7.	Insulating Cement	0.7	1700		SS-C-160
8.	Phenolic	0.13	250	2.5	ASTM C 1126
9.	Flexible Elastomeric	0.27	220		ASTM C 177 or C518
10.	Polyolefin	0.25	200	2	ASTM C 177 or C518

Finishes Key	
F1.	8-ounce glass cloth
F2.	Insulation cement
F3.	0.016 aluminum, plain, up through 12" pipe size; 0.016 aluminum, corrugated, for pipe sizes 14" and larger
F4.	15-mil PVC
F5.	Foil/reinforced/kraft jacket (vapor barrier)
F6.	1/4-inch weatherproof mastic with glass mesh reinforcement
F7.	1/16" vapor barrier mastic (0.05 perm rating) with glass mesh reinforcement
F8.	White all-service jacket (vapor barrier) with self-sealing lap, or taped joints
F9.	Two coats vinyl lacquer type white paint
F10.	Canvas jacketing of 6 oz. Minimum, 100% cotton woven fabric with 25/50 flame/smoke rating and equal to Fattal's Thermocanvas Recovery Jacket.

3.4 DUCT AND PLENUM INSULATION

A. Outside Air Ducts and Plenums in Concealed or Exposed Locations

1. Minimum R-value: 6.
2. Insulation Materials:
 - a. Rigid Fiberglass.
 - b. Cellular Glass
 - c. Phenolic
3. Application Type: D1.
4. Indoor Finish: F8.
5. Outdoor Finish: F1 and F2.

B. Supply Air Ducts and Plenums in Concealed Locations

1. Minimum R-value: 6.
2. Insulation Materials: Fiberglass Flexible Duct Wrap.

3. Application Type: D2.
4. Indoor Finish: F5.
5. Outdoor Finish: F1 and F2.

C. Supply Air Ducts and Plenums in Exposed Locations

1. Minimum R-value: 6.
2. Insulation Materials:
 - a. Rigid Fiberglass.
 - b. Cellular Glass
 - c. Phenolic
3. Application Type: D1.
4. Indoor Finish: F8.
5. Outdoor Finish: F1 and F2.

D. Relief, Return, Exhaust Ducts, and Plenums, and Air Devices in Concealed Locations Under an Exposed Roof.

1. Minimum R-value: 6.
2. Insulation Materials: Fiberglass Flexible Duct Wrap.
3. Application Type: D2.
4. Indoor Finish: F5.
5. Outdoor Finish: F1 and F2.

E. Relief, Return, Exhaust Ducts, and Plenums, and Air Devices in Exposed Locations Under an Exposed Roof.

1. Minimum R-value: 6.
2. Insulation Materials:
 - a. Rigid Fiberglass.
 - b. Cellular Glass
 - c. Phenolic
3. Application Type: D1.
4. Indoor Finish: F8.
5. Outdoor Finish: F1 and F2.

F. Ducts Installed on Roof and Exposed

- 1. Minimum R-value: 6.**
- 2. Insulation Materials:**
 - a. Rigid Fiberglass.**
 - b. Cellular Glass**
 - c. Phenolic**
- 3. Application Type: D1.**
- 4. Outdoor Finish: F3.**

G. Additional Duct Installations

1. Where Noted on the Plans, Relief Air Ducts, Recirculated Air Ducts, Mixed Air Ducts and Return Air Duct shall be Internally Lined.
2. Items Not Insulated:
 - a. Fibrous-glass ducts.
 - b. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - c. Factory-insulated flexible ducts.
 - d. Factory-insulated plenums and casings.
 - e. Flexible connectors.
 - f. Vibration-control devices.
 - g. Factory-insulated access panels and doors.
3. Where duct is exposed outdoors, protect the ductwork with one of the following:
 - a. F9 with color as chosen by Architect.
 - b. F3 where duct is externally insulated.

3.5 EQUIPMENT INSULATION

A. Equipment above ambient temperature, excluding factory insulated assemblies.

1. Equipment includes, unless otherwise indicated:
 - a. Hot Water:
 - 1) Water-to-Water Heat Exchangers.
 - 2) Expansion tanks.
 - 3) Air Separators.
 - 4) Pumps.
 - 5) Laundry Exhaust Assemblies.
 - 6) Humidifiers.
 - b. Steam:
 - 1) Blowdown Heat Recovery Unit.
 - 2) Blowdown Separator Flash Tanks.
 - 3) Boiler Breeching.
 - 4) Dearator.
 - 5) Flash Tanks.
 - 6) Steam Condensate Pumps.
 - 7) Steam-to-water Heat Exchanger.
 - 8) Steam Surge Tank.
 - c. Exhaust services:
 - 1) Medical gas equipment
2. Insulation Materials:
 - a. Laundry exhaust and humidifiers: High Temperature Fiberglass.
 - b. All others: Rigid Fiberglass.
3. Application Types:
 - a. Laundry exhaust and humidifiers: D1.

- b. All others: E1.
 - 4. Indoor Finish:
 - a. Laundry exhaust: F6 and F3.
 - b. Humidifiers: F10.
 - c. All others: F2 and F1.
 - 5. Outdoor Finish:
 - a. Laundry exhaust: F6 and F3.
 - b. Humidifiers: no application.
 - c. All others: F8 and F3.
- B. Equipment Below Ambient Temperature, excluding factory insulated assemblies.
- 1. Equipment includes, unless otherwise indicated:
 - a. Chilled and Condenser Water:
 - 1) Water-to-Water Heat Exchangers.
 - 2) Expansion tanks.
 - 3) Air Separators.
 - 4) Pumps.
 - 5) Chillers.
 - 2. Insulation Materials:
 - a. Chillers and pumps:
 - 1) Rigid Insulation.
 - 2) Foam Glass.
 - 3) Foam Plastic.
 - b. All others: Rigid Fiberglass.
 - 3. Application Type: E1.
 - 4. Indoor Finish:
 - a. Chillers and pumps (to be used with Insulation Material above, respectively):
 - 1) F2 and F1.
 - 2) F2 and F3.
 - 3) F9.
 - b. All others: F2 and F1.
 - 5. Outdoor Finish:
 - a. Chillers and pumps (to be used with Insulation Material above, respectively):
 - 1) F3.
 - b. All others: F8 and F3.

- C. Equipment insulation thicknesses and performance shall be based on Minimum Pipe Insulation Thickness schedule.

3.6 PIPING INSULATION

- A. Minimum insulation thicknesses are scheduled below.
- B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following unless there is a potential for personnel injury.
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
- D. Fitting and Valve Covers:
 - 1. Fitting covers shall be of preformed PVC for indoor service and metal for outdoor service.
 - 2. Insulation material shall be rigid and of the same or greater material type and thickness, density and conductivity as the adjoining pipe. Blanket inserts will not be allowed.
 - 3. Fittings on fiberglass pipe insulation shall be mitered insulation up to 2" diameter and molded fittings for 2½" and larger.
 - 4. Insulation on steam control valves, pressure reducing valves, calibrated balance valves and triple duty valves shall be provided with a manufactured removable insulation cover. Insulated covers shall be heavy canvas type, filled with insulating material and leather laces or straps to secure cover around valve or fitting.
- E. Chilled Water, Cooling Condensate, and Refrigerant Piping Indoors, Concealed or Exposed.
 - 1. Insulation Materials:
 - a. Cellular Glass, with mitered section fittings only.
 - b. Phenolic.
 - 2. Application Type: P2.
 - 3. Finish:
 - a. In equipment rooms: F8.
 - b. For Foam Glass only:
 - 1) No finish required for concealed installations above ceilings and within shafts.
 - 2) Only field applied ASJ shall be used.
- F. Cryogen piping, Indoor or Outdoor, Concealed or Exposed.
 - 1. Insulation Material: Flexible Elastomeric.
 - 2. Application Type: P2.
 - 3. Finish:
 - a. Indoor: F8.
 - b. Outdoor: F3.

G. Hot Water, Steam, and Steam Condensate, Indoors, Concealed or Exposed.

1. Insulation Material: Rigid Fiberglass.
2. Application Type: P2.
3. Finish: F8.

H. Chilled Water, Heating Hot Water, Cooling Condensate, Domestic Water, and Refrigerant Piping Outdoors, Concealed or Exposed. Note that piping in the airstream of AHUs is considered "outdoors" for this application.

1. Insulation Material: Cellular Glass, with mitered section fittings only and field applied ASJ.
2. Application Type: P2.
3. Finish: F8 and F3.
4. Provide heat trace under insulation for hydronic services subject to freezing.

I. Engine Generators

1. Between engine generator and muffler:
 - a. Insulation material: Calcium silicate.
 - b. Application type: P1.
 - c. Finish: F3.
2. Engine generator muffler:
 - a. Insulation material: Calcium silicate.
 - b. Application type: E1.
 - c. Finish: F3.

MINIMUM PIPE INSULATION THICKNESS							
FLUID TEMP. (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity Btu*in./(h*ft²*°F)	Mean Rating Temp. °F	<1	1 to <1-½"	1-½ to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)							
>350 (Includes HPS)	0.32-0.34	250	2.5	3.0	3.0	4.0	4.0
251-350 (Includes HPR, BF)	0.29-0.32	200	1.5	2.5	3.0	3.0	3.0
201-250 (Includes LPS, LPR)	0.23	150	1.5	1.5	3.0	3.0	3.0
141-200 (Includes HS, HR)	0.23	125	1.5	1.5	2.0	2.0	2.0
105-140	0.23	100	1.5	1.5	2.0	2.0	2.0
Cooling Systems (Chilled Water, Brine, and Refrigerant)							
≥40	0.36	100	1.5	1.5	1.5	2.0	2.0
<40	0.36	100	1.5	1.5	1.5	2.0	2.0

Notes:

1. The above table is applicable to insulations in the conductivity ranges stated only. For insulation outside these conductivity ranges, the minimum thickness (T) shall be determined by the following calculation and the calculation submitted for acceptance:

$$T = r \{ (1 + t/r)^{K/k} - 1 \}$$

T = Thickness

r = Actual outside radius of pipe (in.)

t = Insulation thickness per the above table

K = Conductivity of alternate material

k = Upper value of the Conductivity Range per the above table

END OF SECTION

SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
 - 2. Division 23 Section "Modular Central Station AHUs" for additional requirements.

1.2 DEFINITIONS

- A. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- B. BACnet Specific Definitions:
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
 - 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 - 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 - 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
 - 5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- C. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- E. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- F. DDC: Direct digital control.

- G. EPO: Emergency power off. An emergency push-button used to de-energize connected power equipment. EPOs are typically installed at room egresses and have a guard to prevent accidental activation.
- H. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- I. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- J. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- K. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- L. MTBF: Mean time between failures.
- M. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicate on peer-to-peer network for transmission of global data.
- N. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- O. PC: Personal computer.
- P. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- Q. PID: Proportional plus integral plus derivative.
- R. RTD: Resistance temperature detector.
- S. UPS: Uninterruptible power supply.
- T. USB: Universal Serial Bus.

1.3 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - o. Carbon Monoxide: Plus or minus 5 percent of reading.
 - p. Carbon Dioxide: Plus or minus 50 ppm.
 - q. Electrical: Plus or minus 5 percent of reading.

1.4 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

C. LEED Submittals:

1. Include supporting data showing energy, flow, gas, moisture, motion, pressure, and temperature instruments, where and if used in Project; and associated application for monitoring and control to satisfy requirements of Project LEED credits.
 - a. Indicate applicable locations and area coverage, control set points, description of control operation and other required information to satisfy submission requirements for award of LEED credit.
 2. Organize and identify standalone, supporting data for each LEED credit.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.
 4. Details of control panel faces, including controls, instruments, and labeling.
 5. Written description of sequence of operation.
 6. Schedule of dampers including size, leakage, and flow characteristics.
 7. Schedule of valves including flow characteristics.
 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
- E. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Software license required by and installed for DDC workstations and control systems.
- F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
 - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - g. Engineering, installation, and maintenance manuals that explain how to:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
 - h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 - i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
 - j. List of recommended spare parts with part numbers and suppliers.
 - k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - m. Licenses, guarantees, and warranty documents.
 - n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - o. Owner training materials.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- F. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- G. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- H. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- I. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, and thermostat.
2. Maintenance Materials: One thermostat adjusting key(s) per floor or 50,000 sqft of total conditioned space, whichever is greater.
3. Maintenance Materials: One pneumatic thermostat test kit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Andover.

2.2 GENERAL REQUIREMENTS

- A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the provision, installation and extension of the existing building automation and Control System (FMS) including all related systems and accessories.
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems.
- C. System points lists included in the Documents are intended to show the desired alarm, monitoring and control points. Add any control points necessary and as required to accomplish the sequence of operations.
- D. The FMS/DDC shall use BACnet/IP protocol capable of communicating over an Ethernet system. It shall be capable of residing on the corporate enterprise WAN/LAN by having an assigned IP address.
- E. All controllers, whether local field installed or packaged with equipment, shall utilize the BACnet MSTP protocol or include an interpreter to communicate the same to the FMS network.
- F. Provide a UPS with minimum 15 minutes backup for:
 1. All building controllers where the loss of memory or program content would result in the event of power loss.
 2. Supply and return AHU damper actuators.
 3. All smoke control components.
- G. For AHUs, each individual operating state shall have an individual PID control loop for that state.
- H. Controls color graphic displays. Match existing functionality and the following:
 1. Color graphic floor plan displays, and system schematics for each piece of mechanical equipment (including air handling units, variable air volume boxes, fan coils, unit ventilators, cabinet heaters, exhaust fans, fin tube radiation, chilled water systems, hot water boiler systems, and so forth) shall be provided, as specified in the point lists of the Documents, in order to optimize system performance analysis, speed alarm recognition, and simplify user interaction. Configure the color graphics and plot all associated

- control/monitoring points on the screen. Copies of all color graphics screens shall be provided as color printouts to the engineer for approval.
2. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or test-based commands. Floor plans shall display room numbers and each zone shall be color-coded. The operator shall be able to point and click on a room or zone of rooms (in the case of an air handler that serves more than one zone). The room or zone will display an animated flow diagram of the mechanical equipment that serves that zone, with all control and monitoring points associated with that piece of equipment, including setpoints. Setpoints shall be overridden or modified from this screen.
 3. Dynamic Animated Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention. Damper and valve positions, air and water flow shall be animated and shall represent actual, current conditions.
 4. System Performance Analysis Screens: System performance analysis screens shall be provided for the major mechanical systems (such as air handlers, chillers, boilers, and so forth.). For each of these systems, the screen shall be split into quadrants, simultaneously displaying the following data:
 - a. Quadrant 1. – Dynamic animated flow diagrams.
 - b. Quadrant 2. – All analog values associated with the mechanical system shall be graphed on an X-Y axis graph. Five-minute samples for the last twenty-four hour period shall plotted. Scaling shall be automatic.
 - c. Quadrant 3. – Text sequence of operations from engineering as-built submittals.
 - d. Quadrant 4. – Space temperature summaries from each zone being served by mechanical system.
 5. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting Work in progress.
 6. Alarm Annunciation: Any point in a state of alarm shall change the color of its symbol to red until it is no longer in alarm.
 7. AHU Summary Graphic Screen: An AHU summary graphic screen shall be provided for economizer and non economizer AHU's as follows:
 - a. AHU's without economizer cycles shall include a summary graphic screen including the following information:
 - 1) Air Handling Unit
 - a) AHU number
 - b) Supply air temperature
 - c) Supply air temperature setpoint
 - d) Supply air cfm setpoint
 - e) Total terminal box airflow
 - f) Chilled water valve position in %
 - g) Return air temperature
 - h) Return air humidity in %
 - i) Outside air temperature
 - j) Outside air humidity
 - 2) Chilled Water Secondary System
 - a) Chilled water supply temperature

- b) Chilled water return temperature
 - c) Chilled water flow in gpm
 - d) Building load in tons
 - e) Chilled water system differential pressure
 - f) Chilled water system differential pressure setpoint
 - g) Each chilled water pump speed in %
 - 3) Chillers
 - a) Each chillers chilled water supply temperature.
- b. AHU's with economizer cycles shall include a summary graphic screen including the following information:
 - 1) Air Handling Unit
 - a) AHU number
 - b) Supply air temperature
 - c) Supply air temperature setpoint
 - d) Return air temperature
 - e) Outside air temperature
 - f) Outside air humidity
 - g) Mixed air temperature
 - 2) Outside Air
 - a) Outside air cfm setpoint
 - b) Outside air cfm measured
 - c) Return fan speed %
 - d) Supply Fan speed %
 - e) Supply static pressure setpoint
 - f) Supply static pressure actual
 - 3) Dampers
 - a) Economizer damper open position %
- I. Systems integration/FMS specific requirements
 - 1. Open Systems Integration: VFD Integrator Interface
 - a. The FMS shall include appropriate hardware equipment and software to allow two-way data communications between the FMS and the VFD manufacturer's control panel.
 - b. Coordinate with the VFD manufacturer to provide a functional data communications connection.
 - c. All data supported by the VFD communication protocol shall be mapped into the supervisory DDC controller's database and shall be displayed on data screens at the Operator Workstation and shall be transparent to the operator.
 - d. Furnish a BACnet communications interface as required by the VFD manufacturer.
 - e. Provide all communications and power wiring and gateway panel installation for the DDC system. The VFD manufacturer shall provide all hardware for connection of the manufacturer's processor.
 - f. Provide all hardware and software required for the VFD manufacturer's gateway interface.

2. Open Systems Integration: Boiler Integrator Interface

- a. The FMS shall include appropriate hardware equipment and software to allow two-way data communications between the FMS and the boiler manufacturer's Master Boiler Controller Control Panel.
- b. Coordinate with the boiler manufacturer to provide a functional data communications connection.
- c. Furnish BACnet communications interface.
- d. Provide all communications and power wiring and gateway panel installation for the DDC system. The boiler manufacturer shall provide all hardware for connection of the manufacturer's processor.
- e. Provide all hardware and software required for the boiler manufacturer's gateway interface.

J. Alarm management

1. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, to minimize network traffic, and to prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.
2. Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
3. Prioritization:
 - a. Set up all system analog points with high and low alarm limits. All digital system points shall be associated with a status feedback point and all exceptions shall be reported as alarms. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized and filtered to minimize nuisance reporting and to speed operator response to critical alarms.
 - b. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
4. Critical and Non-Critical Alarm Routing:
 - a. Critical alarms shall be defined as chiller, boiler, generator, critical space temperature or humidity, and kilowatt demand approaching threshold. Critical alarms shall be displayed at the workstation, printed at the alarm printer, and alpha paged to the on-duty maintenance person over the Owners alphanumeric paging system. Alpha pages shall provide sufficient information to identify the equipment and the point in alarm and the time and date of occurrence.
 - b. All other alarms shall be considered non-critical and shall be displayed and acknowledged before being sent to the alarm log.
5. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
6. Alarm Messages:
 - a. In addition to the point's descriptor and the time and date, the user shall be able to print, display, or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.

- b. Each stand-alone DDC panel shall be capable of storing a minimum library of 250 Alarm Messages. Each message may be assignable to any number of points in the panel.
- 7. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request is made, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

2.3 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound and SI (metric).
 - 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 - 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic. second response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- E. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. Enclosures:
 - a. For Conditioned Space: Dustproof rated for operation at 32 to 120 deg F.
 - b. For Outdoor and Non-conditioned Space: Waterproof rated for operation at -10 to 150 deg F.

2.5 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 1. Alarm Condition: Indicating light flashes and horn sounds.
 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 3. Second Alarm: Horn sounds and indicating light is steady.
 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.

2. Proportional band shall extend from 2 to 20 percent for 5 psig.
3. Authority shall be 20 to 200 percent.
4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
5. Gauges: 1-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.7 INPUT DEVICES

- A. General Requirements: Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

- B. Temperature Sensors

1. General Requirements:

- a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

- 1) 0.5 deg F:

- a) Chilled Water.
- b) Room Temperature.
- c) Duct Temperature.

- 2) 0.75 deg F: All others

2. Room Temperature Sensors

- a. Room sensors shall be constructed for either surface or wallbox mounting.
- b. Room sensors shall have the following options:

- 1) Setpoint reset slide switch providing a +5 degree (adjustable) range.
- 2) Individual heating/cooling setpoint slide switches.

3. Room Temperature Sensors with Integral Display:

- a. Room sensors shall be constructed for either surface or wallbox mounting.
- b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:

- 1) Display room temperature.
- 2) Display and adjust room comfort setpoint.
- 3) Display and adjust fan operation status.
- 4) Timed override request push button with LED status for activation of after-hours operation.
- 5) Display controller mode.
- 6) Password selectable adjustment of setpoint and override modes.

4. Thermowells:

- a. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
- b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
- c. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
- d. Thermowells shall be constructed of 316 stainless steel.

5. Outside Air Sensors:

- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
- b. Sensors shall be shielded by a perforated plate that surrounds the sensor element.
- c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors:

- a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
- b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

7. Averaging Sensors:

- a. Similar to JCI TE6300.
- b. For ductwork greater in any dimension than 48 inches, inside air handling units, and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
- c. A 20 foot averaging continuous sensor shall be serpentine across the cross section with minimum 1 foot of length for every square foot of cross sectional area. Capillary supports at the sides of the duct shall be provided to support the sensing string.

C. Current Sensing Relays

1. Current sensor shall induce power from the monitored load and shall have an adjustable operating range from 2.5 - 135 A.
2. Visual indicators (LED's) shall indicate output status and sensor power.
3. Adjustable trip set point to +/- 1%.
4. Current sensor output shall be normally open, solid state, 0.1A @ 30 VAC/DC.

D. Humidity Sensors:

1. The sensor shall be a solid state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion.

- a. Indoor locations and sensors mounted in air handling units or ducts; +/- 3%.

- b. Outdoor locations: Humidity Sensor shall be HyCal +/- 2 %.
 - 4. Outside air relative humidity sensors shall include a rain proof, perforated cover. The transmitter shall be include in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
 - 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
 - 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- E. Differential Pressure Transmitters:
- 1. Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Differential pressure transducers shall be piped to permit equalizing pressure prior to disconnecting.
 - c. Differential pressure sensors used to control equipment such as fans and pumps, shall be connected directly to the same controller that controls the equipment to insure the continued proper operation of the controlled equipment without dependence on the control network.
- F. Flow measuring devices:
- 1. Air Flow Measuring:
 - a. General:
 - 1) Airflow measuring sensors shall be installed at fan inlet whenever possible and shall be capable of continuously measuring the air handling capacity (air volume) of the respective centrifugal, plug, or vane-axial fan(s).
 - b. Manufacturers:
 - 1) Paragon Controls Incorporated (PCI), MicroTrans EQ.
 - c. Fan Inlet Piezometer Rings
 - 1) Factory tap fan inlet with sensor ports.
 - 2) Accuracy: +/-3% of Full Scale.
 - d. Duct mounted:
 - 1) Manufacturers:
 - a) Ebtron.
 - 2) Description: Thermal dispersion type. Units shall be provided complete with differential pressure transducers, temperature compensation, square root extraction. Unit shall perform all internal calculations to output to the FMS the CFM readings.
 - 3) Location: Provide straight duct before and after device according to the sensor manufacturer's recommendations. Provide access door in ductwork adjacent to sensors.

- 4) Accuracy: Sensor accuracy shall be $\pm 2\%$ of the airflow reading over the entire range of airflow measured.

e. Transmitter / Transducer

- 1) Each sensor shall be provided complete with transmitter.
- 2) Manufacturers:
 - a) Paragon.
- 3) Full Scale Accuracy:
 - a) Accuracy: $\pm 0.25\%$ of Full Scale.
 - b) Terminal Point Non-linearity: $\pm 0.2\%$.
 - c) Hysteresis: $\pm 0.2\%$.
 - d) Non-repeatability: $\pm 0.3\%$.
 - e) Temperature Effect: $\pm 0.15\%$ Full Scale / $^{\circ}\text{F}$.
- 4) The transmitter-controller shall be capable of receiving flow signals (total and static pressure) from an airflow station or probe array and produce an output linear and scaled for air volume, velocity, differential pressure, etc. The internal P, I, three-mode controller shall be capable of controlling at a user selectable internal or external setpoint, and output a 0-5VDC, 0-10VDC, or 4-20mA DC control signal.
- 5) The transmitter-controller shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output plus controller setpoint during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.
- 6) The transmitter-controller will be available in multiple natural spans covering the range of 0.05" w.c. to 10.0" w.c. The transmitter-controller shall be furnished with a transducer automatic zeroing circuit, and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity or pressure turndown.
- 7) The transmitter-controller shall be capable of having its operating span electronically selected without having to perform recalibration involving an external pressure source. The transmitter-controller will provide the means of managing a system for automatic high pressure purge of the airflow station or probe array, with user selectable purge frequency and duration, while maintaining the last transmitter output during the purge cycle. Using a second transmitter as an input, the internal microprocessor can perform a summed flow, flow differential, low signal select, high signal select or percent deviation calculation, with the result being displayed and provided as an analog output signal.

2. Water Flow Measuring:

a. General:

- 1) Sensors shall operate in line pressures up to 400 psi and liquid temperatures up to 220°F .
- 2) A certificate of calibration shall be provided with each flow meter.
- 3) Each flow meter shall be covered by the manufacturer's two-year warranty.

- b. Turbine:
 - 1) Manufacturer:
 - a) Onicon, F-1100 or F-1200 Series.
 - 2) Accuracy:
 - a) Less than 2 ft/sec: $\pm 0.02\%$.
 - b) 2 to 30 ft/sec: $\pm 1\%$.
 - 3) Provide complete sensor assembly with all installation hardware necessary to enable insertion and removal of the meter without system shutdown.
 - 4) Materials of construction for wetted metal components shall be 316 SS.
 - 5) Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1%.
 - 6) Output signals shall be completely isolated and shall consist of the following:
 - a) (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable
 - b) (1) scalable dry contact output for totalization
 - c) (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter.
- c. Transmitter / Transducer
 - 1) Each sensor shall be provided complete with transmitter.
 - 2) Water meter: The analog transmitter shall be Data Industrial Model 310-00, or equivalent.
 - 3) The analog flow transmitter shall be a loop powered device capable of transmitting a linear 4 - 20 mA signal proportional to frequency. The unit shall be microprocessor controlled with no switches or potentiometers to set.
 - 4) The transmitter shall meet ISA Class L, H and U non-isolated requirements. All circuitry shall be encapsulated in a low profile epoxy body to meet MIL spec M.1- 146058C type AR, for humidity, moisture and fungus resistance. Operating range shall be 35°F to 150°F.
 - 5) All programming, including flow sensor selection, pipe size, flow range setting, response time and filtering shall be set digitally via a computer using Windows-based software with programming kit (disk and cable). The transmitter shall be easily programmed in the field using a standard computer.
 - 6) The transmitter shall have a ground lug to maximize EMI protection when necessary. The transmitter shall be mounted directly near the insertion flow sensor on a DIN Rail, as a panel mount or in a weather proof or NEMA 4X enclosure.

G. Power Monitoring Devices:

- 1. Current Measurement (Amps):
 - a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
 - b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.

- 1) Operating frequency – 50 - 400 Hz.
- 2) Insulation – 0.6 Kv class 10Kv BIL.
- 3) UL recognized.
- 4) Five amp secondary.
- 5) Select current ration as appropriate for application.

c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

- 1) 6X input over amp rating for AC inrushes of up to 120 amps.
- 2) Manufactured to UL 1244.
- 3) Accuracy: +.5%, Ripple +1%.
- 4) Minimum load resistance 30kOhm.
- 5) Input 0-20 Amps.
- 6) Output 4-20 mA.
- 7) Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

H. Smoke Detectors:

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be as specified in Division 28 - Fire Alarm System.

I. Status and Safety Switches:

1. General Requirements:

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches:

- a. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Air Filter Status Switches:

- a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
- b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
- c. Provide appropriate scale range and differential adjustment for intended service.

4. Air Flow Switches:

- a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
- 5. Air Pressure Safety Switches:
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
- 6. Water Flow Switches: Equal to the Johnson Controls P74.
- 7. Low Temperature Limit Switches: Equal to Johnson Controls A70.
 - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be one foot long for each square foot of coil area and be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

J. EPO Switches

- 1. General Description: All products listed shall meet the following requirements:
 - a. Operators shall be heavy duty type and comply with UL Type 13/NEMA Type 13 and UL Type 6/NEMA Type 6.
 - b. Contact blocks shall be rated 10 amperes continuous.
- 2. EPO Design:
 - a. Mushroom type: Flush mounted, two position, maintained push - maintained pull mushroom head type push button operator with 2.25 inch diameter mushroom top, red, with one normally open and one normally closed (1NO - 1NC) contact. Provide with aluminum extended mushroom guard.

2.8 OUTPUT DEVICES

A. Actuators:

- 1. General Requirements:
 - a. Damper and valve actuators shall be electronic, as specified in the System Description section.
- 2. Electronic Damper Actuators:
 - a. Electronic damper actuators shall be direct shaft mount as manufactured by Belimo.
 - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator

manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, or a gear release to allow manual positioning.

- c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, proportional control.
- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

3. Electronic Valve Actuators:

- a. Electronic valve actuators shall be manufactured by the valve manufacturer or Belimo Air Controls. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
- b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close off against the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
- c. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, proportional control.
- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

B. Control Dampers:

- 1. Furnish all automatic dampers that are not furnished with air handling units. Coordinate exact damper requirements with the air handling unit manufacturer. All automatic dampers shall be sized for the application or as specifically indicated on the Drawings.
- 2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- 3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.
- 4. All dampers used for smoke control applications shall be UL 555 listed.
- 5. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48". Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be

provided for any section exceeding 48" in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomeric seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.5 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

6. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g.
7. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.
8. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays:

1. Control Pilot Relays:

- a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
- b. Mounting bases shall be snap-mount.
- c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
- d. Contacts shall be rated for 10 amps at 120VAC.
- e. Relays shall have an optional indicator light and check button.

D. Control Valves:

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Section.
2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no more than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no more than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no more than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all hot and chilled water applications, except those described hereinafter. The valve discs shall be composition type. Valve stems shall be stainless steel.
4. Ball valves shall be acceptable for water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless

steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

6. Control valves for ball valves shall not use pulse of tri-mode controllers or actuators. Controllers installed shall be capable of being spanned for the two stem travel ranges of 0-20% open and 85-100% open.

E. Electronic Signal Isolation Transducers:

1. A signal isolation transducer shall be provided whenever an analog output signal from the Facility Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.

F. Motor starters: an integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.

1. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
2. A Status LED shall illuminate whenever the output is ON.
3. An Override LED shall illuminate whenever the HAND/OFF/AUTO switch is in either the HAND or OFF position.
4. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

G. Variable frequency motor controllers: an integral HAND/AUTO pushbutton shall override the controlled device pilot relay.

1. A status input to the Facility Management System shall indicate whenever the controller is in the hand or bypass position.
2. A Status LED shall illuminate whenever the output is ON.
3. An Override LED shall illuminate whenever the HAND/AUTO pushbutton is in either the HAND or OFF position.
4. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.9 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

1. Connect and configure equipment and software to achieve sequence of operation
- B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and architectural room details before installation. Install devices 48 inches above the floor.
- C. Install manual reset switches, such as high and low static resets, no higher than 6'-0" above nearest adjacent finished floor.
- D. Install averaging elements in ducts, plenums, and coil faces in crossing or zigzag pattern. Provide one linear foot of sensor per square foot of coil in a pattern that will create an even distribution of sensor over the entire cross sectional area of duct or air handling unit.
- E. Install freezestats to provide one linear foot of sensor per square foot of coil.
- F. Install temperature sensor on the leaving side of all cooling and heating coils in AHUs.
- G. Install outdoor air temperature sensors on a north facing wall and away from direct sunlight as well as 20 feet (minimum) from exhaust or relief air fans.
- H. Install outdoor air humidity sensors on a north facing wall and away from direct sunlight as well as 20 feet (minimum) from exhaust or relief air fans. Do not install within 20 feet of cooling tower discharge, steam vents, or downstream of similar services in the direction of typical wind patterns.
- I. Install temperature and flow meters to calculate building BTUH use for the following systems:
 1. Chilled Water.
 2. Heating Water.
- J. Flow Station Locations:
 1. Air side
 - a. Provide piezometer ring type at fan inlet for all fans located in AHUs and as indicated on drawings.
 - b. Fans external to AHU are to be piezometer type.
 - c. Fans external to AHU to be thermal dispersion type installed at the fan inlet.
 - d. Duct mounted flow stations shall be thermal dispersion type.
 2. Water side
 - a. Water flow stations shall be turbine type.
 - b. Flow meters shall be installed in the following locations as a minimum:
 - 1) chilled water loops
 - 2) heating water loops
 - c. Adequate straight pipe shall be installed before (10 pipe diameters) and after (5 pipe diameters) device according to the manufacturer's recommendations.
- K. Install pressure monitors across walls dividing a spaces with monitored pressure requirements, including the following applications:
 1. Soiled.
 2. Decontamination.

- L. Coordinate EPO switch location and type with Division 26. Install EPOs as follows:
 - 1. Mushroom:
 - a. Boilers
- M. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- N. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- O. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- P. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- Q. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."
- R. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- S. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- T. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."
- U. Unit Heaters: Unit heaters shall each be provided with a low voltage electric wall-mounted room thermostat, which shall cause the heater to be cycled "on" or "off" as required to satisfy the thermostat setting. Control circuit voltage shall not exceed 120 volts to ground.

3.3 EQUIPMENT STATUS MONITORS

- A. Current sensing relays are to be installed across motors and must be sensitive enough to detect and alarm when driven equipment, such as a fan motor is operating without a belt or a pump motor is operating without flow.
- B. Where a current sensing relay is not sensitive as described above, provide differential pressure transducers/switches to monitor equipment status.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

2. Install exposed cable in raceway.
 3. Install concealed cable bundled, labeled for service, and well supported to prevent contact with other systems.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches or hand/auto push buttons to override automatic interlock controls when switch or pushbutton is in hand position.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.
 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.
 10. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.

- b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire, including:
 - 1) Status indicators for fans shall be tested to indicate an alarm upon belt loss or dead-head pump condition. Adjust current sensing relays appropriately.
 - 2) Status indicators for preheat circulating pumps shall be tested to indicate an alarm upon dead-head condition. Adjust current sensing relay appropriately.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide for visits to Project during other than normal occupancy hours for this purpose.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 231123

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results" for escutcheons and grout.
2. Division 23 Section "Hangers and Supports" for hangers.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.
5. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple

pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/8 inch per foot.

- C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- D. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- E. Welding certificates.
- F. Field quality-control reports.
- G. Operation and Maintenance Data: For motorized gas valves, pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than ten days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 6. Mechanical Couplings:
 - a. Available Manufacturers:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.

- b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Available Manufacturers:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
- 6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Available Manufacturers:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.
 - e. Acetal collets.
 - f. Stainless-steel bolts, nuts, and washers.
- 7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Available Manufacturers:

- 1) Dresser Piping Specialties; Division of Dresser, Inc.
- 2) Smith-Blair, Inc.

- b. Stainless-steel flanges and tube with epoxy finish.
- c. Buna-nitrile seals.
- d. Stainless-steel bolts, washers, and nuts.
- e. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 100 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 100 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
 - 1. Available Manufacturers:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated brass.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Separate packnut with adjustable-stem packing threaded ends.
 - 7. Ends: Threaded, flared, or socket as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Available Manufacturers:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Available Manufacturers:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Available Manufacturers:
 - a. McDonald, A. Y. Mfg. Co.
 - b. Mueller Co.; Gas Products Div.
 - c. Xomox Corporation; a Crane company.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Available Manufacturers:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A. Y. Mfg. Co.

- d. Milliken Valve Company.
 - e. Mueller Co.; Gas Products Div.
 - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Article.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. PE Ball Valves: Comply with ASME B16.40.
1. Available Manufacturers:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 5. Seats and Seals: Nitrile.
 6. Ends: Plain or fusible to match piping.
 7. CWP Rating: 80 psig.
 8. Operating Temperature: Minus 20 to plus 140 deg F.
 9. Operator: Nut or flat head for key operation.
 10. Include plastic valve extension.
 11. Include tamperproof locking feature for valves where indicated on Drawings.
- I. Valve Boxes:
1. Cast-iron, two-section box.
 2. Top section with cover with "GAS" lettering.
 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
 4. Adjustable cast-iron extensions of length required for depth of bury.
 5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

- A. Automatic Gas Valves: Comply with ANSI Z21.21.
1. Available Manufacturers:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Dungs, Karl, Inc.
 - c. Eaton Corporation; Controls Div.
 - d. Eclipse Combustion, Inc.

- e. Honeywell International Inc.
 - f. Johnson Controls.
 - 2. Body: Brass or aluminum.
 - 3. Seats and Disc: Nitrile rubber.
 - 4. Springs and Valve Trim: Stainless steel.
 - 5. Normally closed.
 - 6. Visual position indicator.
 - 7. Electrical operator for actuation by appliance automatic shutoff device.
- B. Electrically Operated Valves: Comply with UL 429.
- 1. Available Manufacturers:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Dungs, Karl, Inc.
 - c. Eclipse Combustion, Inc.
 - d. Goyen Valve Corp.; Tyco Environmental Systems.
 - e. Magnatrol Valve Corporation.
 - f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
 - g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - 2. Pilot operated.
 - 3. Body: Brass or aluminum.
 - 4. Seats and Disc: Nitrile rubber.
 - 5. Springs and Valve Trim: Stainless steel.
 - 6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
 - 7. NEMA ICS 6, Type 4, coil enclosure.
 - 8. Normally closed.
 - 9. Visual position indicator.

2.6 PRESSURE REGULATORS

- A. General Requirements:
- 1. Single stage and suitable for natural gas.
 - 2. Steel jacket and corrosion-resistant components.
 - 3. Elevation compensator.
 - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80.
- 1. Available Manufacturers:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - d. Invensys.
 - e. Richards Industries; Jordan Valve Div.
 - 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 - 3. Springs: Zinc-plated steel; interchangeable.
 - 4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Available Manufacturers:
 - a. Actaris.
 - b. American Meter Company.
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - e. Invensys.
 - f. Maxitrol Company.
 - g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: **[2 psig] [5 psig]**.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Available Manufacturers:
 - a. Canadian Meter Company Inc.
 - b. Eaton Corporation; Controls Div.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 - e. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: [1 psig] [2 psig] [5 psig].

2.7 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Available Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - f. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 100 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. Available Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - d. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 100 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:

1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
2. Minimum Operating-Pressure Rating: 100 psig.
3. Companion-flange assembly for field assembly.
4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
5. Insulating materials suitable for natural gas.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.8 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.9 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. For renovations and additions close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and all applicable codes to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and all applicable code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and all applicable codes for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.
- F. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
- G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and all applicable codes for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons, after Architect's final approval of finish, for penetrations of walls, ceilings, and floors according to the following:
 1. New piping penetrations shall be one-piece escutcheons.
 2. Existing piping penetrations shall be two-piece escutcheons.
 3. All sleeved penetrations shall be deep-drawn to allow flush installation between escutcheon and finished surface.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in pipe spaces, utility spaces, above ceilings, in floor channels unless indicated to be exposed to view.
- R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 - 3. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23Section "Meters and Gages for HVAC Piping."

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install earthquake valves aboveground outside buildings according to listing.
- D. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance of appliances.

- B. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- C. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and all applicable codes and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

2. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping NPS 2 and smaller shall be the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping NPS 2-1/2 and larger shall be one of the following:
 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, nonlubricated or lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION

SECTION 232113

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Safety-valve-inlet and -outlet piping.
8. Pre-insulated piping systems.

B. Related Sections include the following:

1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
2. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
3. Division 23 Section "Heat Tracing for HVAC Piping" for heat tracing system requirements and applications.
4. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
5. Division 23 Section "HVAC Water Treatment" for water-treatment chemicals, equipment, and controls.
6. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
7. Division 23 Section "Steam and Condensate Heating Piping".
8. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding 150 psig at the corresponding temperature as the minimum working pressure and temperature, unless otherwise indicated:

1. Hot-Water Heating Piping: 200 deg F.
2. Chilled-Water Piping: 200 deg F.
3. Makeup-Water Piping: 200 deg F.
4. Condensate-Drain Piping: 200 deg F.
5. Blowdown-Drain Piping: 200 deg F.
6. Air-Vent Piping: 200 deg F.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
8. Pre-insulated Piping Systems: Same as the piping system to which it is attached.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air control devices.
 - 3. Hydronic specialties.
- B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Qualification Data: For Installer.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
- E. All underground distribution systems shall be designed in strict conformance to the latest edition of ANSI B31.1 or local requirements, whichever is more stringent, and sealed by a Registered Professional Engineer in good standing with state and local authorities. The system shall be designed to compensate for stresses and movement of the service pipe.

1.5 QUALITY ASSURANCE

- A. All piping shall be American manufactured, unless otherwise indicated.
- B. Installer Qualifications:
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.6 EXTRA MATERIALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
 - 1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 - 2. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers:
 - a. Anvil International, Inc.
 - b. Grinnell, Inc.
 - c. Victaulic Company of America.
 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 PRE-INSULATED PIPE AND FITTINGS

A. Pipe And Insulation Materials:

1. Manufacturers:
 - a. Perma-Pipe. (Basis-of-design: Terra-Gard)
 - b. Thermacore.
2. Internal service pipe shall be A53/A106 seamless carbon steel pipe. Pipe thickness / schedule shall be as described for fluid service.
3. The system design shall be in strict conformance with ANSI B31.1, latest edition.
4. End seals, gland seals and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system.
5. Outer conduit shall be smooth wall, welded steel:
 - a. For sizes up to 26 NPS, 10 ga.
 - b. For sizes 28 NPS to 36 NPS, 6 ga.
 - c. For sizes 38 NPS to 42 NPS, 4 ga.
6. Insulated service pipe shall be supported minimum 10 ft on center. From outer conduit. Supports shall not directly contact service pipe.
7. Internal service pipe shall be insulated per Division 23 "HVAC Insulation".
8. All pre-insulated sections shall have a factory applied PVC outer covering 60mils minimum thickness. All fittings, bellows, and anchors of the insulated piping system shall be prefabricated to job dimensions.
9. Provide x-ray inspection of the entire length to ensure there are no insulation voids.

B. Accessories:

1. Leak detection: Provide complete system including sensors, control panel, and interface with FMS to continuously monitor and locate moisture intrusion within the casing.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
 - 1. Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
 - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges:
 - 1. Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits:
1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings:
1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples:
1. Manufacturers:
 - a. Grinnell Mechanical Products.
 - b. Perfection Corporation; a subsidiary of American Meter Company.
 - c. Precision Plumbing Products, Inc.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Victaulic Company of America.
 2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 4 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 2. Standard weight steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 5 and larger, shall be any of the following:

1. Standard weight steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 2. Standard weight steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- C. Chilled-water piping, aboveground, NPS 4 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 2. Standard weight steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- D. Chilled-water piping, aboveground, NPS 5 and larger, shall be any of the following:
1. Standard weight steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 2. Standard weight steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- E. Chilled-water piping installed belowground shall be any of the following:
- F. Makeup-water piping installed aboveground shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
- G. Makeup-Water Piping Installed Belowground: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- H. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- I. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- J. Air-Vent Piping:
1. Inlet: Same as service where installed according to the piping manufacturer's written instructions.
 2. Outlet: Type L, annealed-temper copper tubing with soldered or flared joints.
- K. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed according to the piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Cut pipe to measurements established at site and work into place with forcing or springing.

- C. Piping shall be installed by skilled mechanics using designated basic materials plus any required supplementary materials.
- D. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping to permit valve servicing.
- H. Install piping at indicated slopes.
- I. Install piping straight and true, free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install piping to allow application of insulation.
- L. Select system components with pressure rating equal to or greater than system operating pressure.
- M. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- P. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- T. Welder shall stamp each weld in order to identify the individual who completed the work.

3.3 PIPE GRADING

- A. General: Grade each system in accordance with good established practice to avoid air pockets, to relieve liquids and vent gases. Grade uniformly between indicated elevations or at indicated slope. Slopes shown on plans shall take precedence over any listed herein.

- B. Steam and Condensate Return Lines: Grade to insure steam delivery to and discharge of condensate from utilizing devices. Minimally grade steam and condensate return lines down 1" in 40 feet when graded down in the direction of flow. Grade steam lines down 1" in 20 feet when back graded. Do not back grade steam piping without permission of Architect. Where horizontal mains change size, keep the bottom of the coupled pipes on the same level using eccentric couplings. Grade steam relief and vent lines back to receiver or other device installed to eliminate tapping float trap. Terminate an atmospheric vent piping in a cast iron exhaust head as detailed.
- C. Heating and Chilled Water Circulating Lines: Lay on an even slope; grade to drain at a valve at the circulating pump whenever possible; where other low points are unavoidable, provide service drains. Where horizontal mains change size, keep the tops of the coupled pipes on the same level using eccentric couplings.
- D. Equipment Drains: Each line from a relief valve, air vent valve, separator or a boiler, drip pan elbow, exhaust head, heat exchanger, compression tank, receiver, pump base, air conditioning unit pan, air washer overflow and drain, evaporator pan, and similar drain shall grade down to a point of open sight discharge and/or as indicated on the drawings.

3.4 HANGERS AND SUPPORTS

- A. Piping support must account for expansion and contraction, vibration, dead load of piping and its contents, and seismic-bracing requirements.
- B. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.5 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Use manufacturer's recommended methods and follow all applicable codes for joining each piping system.
- C. Make square cuts on all pipes using proper tools and alignment devices. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
 - 1. Use solder joint fittings in copper tubing lines.
 - 2. Do not anneal copper tubing and fittings.
 - 3. Tubing shall be cut square, and burrs shall be removed. Insides of fittings and outsides of tubing shall be well cleaned with steel wool, steel brushes, and/or emery cloth before assembly.

4. Installation shall be made by skilled mechanics in accordance with the material manufacturer's recommendations.
 5. Mitering of joints for elbows and notching of straight runs for tees will not be permitted.
 6. All joints shall be made with solid string or wire solder. Fluxes shall be non-corrosive pastes of the proper type. Solder shall be lead free. No cored solder will be permitted.
- F. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- H. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
1. All joints shall be fusion welded by a metallic arc or gas welding process. Pipe ends shall be beveled $37\frac{1}{2}^\circ$. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping, ANSI B31.1, latest edition, amended to date.
 2. Weld rods shall be of the proper type for each application to match the line materials.
 3. If the Engineer so requests, the Contractor shall have each of his welders prepare test coupons which shall be tested in an approved independent testing laboratory and any defects found shall be cause for dismissal of the welder from the project. All cost of such tests shall be borne by the Contractor.
 4. Branch takeoffs not larger than $\frac{2}{3}$ of the main may be made using shaped nipples, weldolets, or threadolets to match branch line fabrication methods.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- J. Copper Fittings
1. Use wrought copper solder joint type in all patterns and sizes available. Use long radius copper elbows wherever available and space will permit.
- K. Welding Fittings
1. All fittings in welded lines shall be factory-fabricated welding fittings of the same material and the same weight or Schedule as the piping attached.
 2. All elbow tees, caps and special fittings including connections into headers shall be standard butt welding fittings, conforming to ANSI B16.9, with the following exception: Branch take-offs from lines $2\frac{1}{2}"$ and larger and where the size of the takeoff does not exceed $\frac{2}{3}$ of the normal diameter of the mains to which connected, may be made with shaped nipples or with Bonney Weldolets or Threadolets as required by the class of fabrication.
 3. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
- L. Flanges

1. At connections to flanged valves and equipment outlets in steel piping systems using welding neck, slip on welding flanges, screwed steel, or cast iron companion flanges.
 - a. It will be permissible to use cast iron flanged fittings at connections to equipment items.
2. In grooved end piping systems use matching flanged adapter nipples.
3. In copper lines use brass flanges.
4. Connecting flanges shall have matching flat or raised faces. Faces shall be free of imperfections that would prevent proper seating.
5. Tighten bolts uniformly all around to prevent any stress.

M. Gaskets

1. Manufactured from proper materials as with performance and materials described in Division 23 "Common Work Results for HVAC", unless otherwise indicated. Full-faced type for flat-faced flanges and ring type for raised-faced flanges.
 - a. Water Lines: Red rubber sheeting.
 - b. Steam and Condensate Return Lines: Non-asbestos sheeting.
 - c. Dielectric Flanges: As provided with the flanges.
 - d. Other Lines: As recommended for the duty.

N. Securing Underground Lines

1. Install pipe clamps and braces using poured in place concrete blocks, or other anchors and supports required to ensure stability of all underground lines to prevent joint separation either during tests or thereafter when lines are in service.
 - a. Pipe Braces and nuts installed in the ground shall be fabricated of stainless steel to resist corrosion.

- O. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."
- E. For hydronic connections less than NPS 2-1/2", provide one of the following, but not both:
 1. Flexible connectors.

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Procedures in subparagraphs below are paraphrased from ASME B31.9.
2. Test piping prior to backfilling, concealing, insulating or painting; isolate pressure sensitive equipment from tests.
 - a. Test portions as required by construction schedule. When previously tested sections are expanded, retest at connections.
 - b. Test new portions as required by construction schedule; test new connections into existing lines.
3. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Air may be substituted as a testing medium instead of water. Refrigerant lines shall be leak tested with air unless otherwise indicated.
4. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
5. Isolate expansion tanks and determine that hydronic system is full of water.
6. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
7. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
8. Prepare written report of testing. All test results shall be submitted to the Owner and Architect. Provide all tests required by acceptable codes.
9. Furnish all compressed air, vacuum and water pumps; tanks of compressed air, nitrogen, carbon dioxide, refrigerant, gauges, plugs, seals, etc., as required to obtain, maintain and measure pressures during tests.
10. Pressure test all systems per governing codes, to a minimum of 1.5 times the working pressure, or the following table, whichever is greater:

Piping System	Test Pressure (psig)
High Pressure Steam (above 15 psig)	200
Low Pressure Steam (15 psig and less)	100
Gravity Steam Condensate Returns	100
Pumped Steam Condensate Return	200
Heating, Chilled, and Condenser Water	150
Refrigerant	450

11. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.
- D. Perform the following prior to operating the heat trace system:
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 2. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 3. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - a. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - b. Test cables for electrical continuity and insulation integrity before energizing.
 - c. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
 4. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
 5. Cables will be considered defective if they do not pass tests and inspections.
 6. Prepare test and inspection reports.

3.8 REPAIRS

- A. Effect repairs as recommended by the manufacturer of the pipe and fittings materials; replace any defective materials. When procedures involve additional work on a joint and they fail, remake the joint. Repair operations shall include:
1. Screwed Joints: Additionally tighten.
 2. Caulked Joints: Additionally caulk.
 3. Welded Joints: Chip out old weld metal and re-weld.
 4. Compression Joints: Re-clean; replace seal, compression rings, couplings, etc.
 5. Mechanical Joints: Re-clean; additionally tighten.
 6. Soldered or Brazed Joints: Remake joint, no additional soldering or brazing allowed.

3.9 CLEANING

- A. Clean all new piping systems and components prior to putting into service.
- B. Hydronic Service Procedure:
 - 1. Cleaning water lines are to be cleaned by placing one 2" connection each end of new run of supply and return pipe and piping with circulating pump to move chemicals through pipe for period of 2 days. Then dump & drain after approval by City of Wichita Falls. Should City not approve dumping, then it shall be the responsibility of the mechanical contractor to arrange disposal of chemical as well as two refills for flushing.
 - 2. Cleaning of CHS and CHR shall be done using solvent or chemical compound acceptable to the City of Wichita Falls and shall contain no phosphates in any form, (Organic Citrus based cleaners have in the past been acceptable). The final cleaning shall meet the latest City of Wichita Falls Water Quality Sample requirements.
 - 3. Refill cleaned system with fresh water to which adequate amounts of suitable chemicals have been added.
- C. Steam and Condensate Return System: Clean all fittings and pipes before installation. After installation, blow out all steam lines with steam and repeat as necessary to insure all foreign particles are removed.
- D. Blow off all strainers.
- E. Waste and Drain Lines: Swab out lines; flush with fresh water.
- F. Repetition: Repeat the above procedures until all parts of each piping system are thoroughly cleaned of all foreign materials.

END OF SECTION

SECTION 232116

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled-water piping.
 - 3. Makeup-water piping.
 - 4. Condensate-drain piping.
 - 5. Blowdown-drain piping.
 - 6. Air-vent piping.
 - 7. Safety-valve-inlet and -outlet piping.
- B. Related Sections include the following:
 - 1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
 - 2. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
 - 3. Division 23 Section "Heat Tracing for HVAC Piping" for heat tracing system requirements and applications.
 - 4. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
 - 5. Division 23 Section "HVAC Water Treatment" for water-treatment chemicals, equipment, and controls.
 - 6. Division 23 Section "Steam and Condensate Piping".
 - 7. Division 23 Section "Steam and Condensate Specialties".
 - 8. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.
- B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - a. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding 150 psig minimum working pressure at the temperature listed below, unless otherwise indicated:
 - 1. Hot-Water Heating Piping: 200 deg F.
 - 2. Chilled-Water Piping: 200 deg F.
 - 3. Makeup-Water Piping: 200 deg F.
 - 4. Condensate-Drain Piping: 200 deg F.
 - 5. Blowdown-Drain Piping: 200 deg F.
 - 6. Air-Vent Piping: 200 deg F.
 - 7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
 - 8. Pre-insulated Piping Systems: Same as the piping system to which it is attached.

2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Manufacturers:
 - a. Armstrong Pumps, Inc.

- b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Griswold Controls.
 - e. Taco.
 - 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 3. Ball: Brass or stainless steel.
 - 4. Plug: Resin.
 - 5. Seat: PTFE.
 - 6. End Connections: Threaded or socket.
 - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 8. Handle Style: Lever, with memory stop to retain set position.
 - 9. CWP Rating: Minimum 125 psig.
 - 10. Maximum Operating Temperature: 250 deg F.
- D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
- 1. Manufacturers:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Grinnell Mechanical Products.
 - e. Griswold Controls.
 - f. Taco.
 - g. Tour & Andersson; available through Victaulic Company of America.
 - 2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
 - 3. Ball: Brass or stainless steel.
 - 4. Stem Seals: EPDM O-rings.
 - 5. Seat: PTFE.
 - 6. End Connections: Flanged or grooved.
 - 7. meter.
 - 8. Handle Style: Lever, with memory stop to retain set position.
 - 9. CWP Rating: Minimum 125 psig.
 - 10. Maximum Operating Temperature: 250 deg F.
- E. Diaphragm-Operated, Pressure-Reducing Valves:
- 1. Manufacturers:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Body: Bronze or brass.
 - 3. Seat: Brass.
 - 4. Stem Seals: EPDM O-rings.
 - 5. Diaphragm: EPT.
 - 6. Low inlet-pressure check valve.
 - 7. Inlet Strainer: Stainless steel, removable without system shutdown.

8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: Stainless steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. Nexus.
 - d. NuTech.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Minimum Operating Temperature: 200 deg F.

2.3 AIR-CONTROL DEVICES

A. Manufacturers:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.
5. Spirotherm.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8.
6. Minimum Simultaneous Operating Point: 150 psig at 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. Minimum Simultaneous Operating Point: 150 psig at 240 deg F.

D. Expansion Tanks, Bladder Type:

1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
4. Bladder shall be sized for full acceptance without failure of the membrane.

E. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity, unless otherwise indicated.

F. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Minimum Simultaneous Operating Point: 175 psig at 300 deg F.

G. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Minimum Simultaneous Operating Point: 150 psig at 250 deg F.

2.4 HYDRONIC PIPING SPECIALTIES

- A. Strainer Perforations: All strainers shall be stainless steel and sized based on the service and installed pipe size as indicated by the table below, unless indicated otherwise.

SERVICE DUTY	PIPE SIZE (NPS)	STRAINER PERFORATION SIZE (in)
Chilled and Hot Water	1/4" to 2"	0.033
	2-1/2" to 4"	0.057
	6" and Larger	0.125"
Condenser Water	1/4" to 2"	0.020
	2-1/2" to 4"	0.045
	6" and Larger	0.100

- B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger. Grooved connections are also acceptable.
3. CWP Rating: 125 psig (860 kPa).

- C. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger. Grooved connections are also acceptable.
3. CWP Rating: 125 psig.

- D. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. CWP Rating: 750 psig.

- E. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

- F. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- C. Install calibrated-orifice, balancing valves at each branch connection to return main.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- G. All valves shall be installed with stems in vertical position, unless otherwise indicated. If not possible, stems may be installed 45° off vertical position where allowed by manufacturer.
- H. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- I. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- J. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Select system components with pressure rating equal to or greater than system operating pressure.
- B. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

- E. Install air separators on chilled and heating water systems.
- F. Install tangential air separator for system on suction side of pump header prior to first pump. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- G. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- H. Install expansion tanks on the floor or suspended as indicated. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 232123

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 2. Close-coupled, end-suction centrifugal pumps.
 - 3. Separately coupled, base-mounted, end-suction centrifugal pumps.
 - 4. Automatic condensate pump units.

1.2 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.
- C. OPD: Open Drip-proof
- D. TEFC: Totally Enclosed Fan Cooled

1.3 ACTION SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS.

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
- B. PACO Pumps.
- C. Taco, Inc. Basis of Design.

2.2 GENERAL HYDRONIC PUMP REQUIREMENTS

- A. Provide hydronic pumps of the type, rotational speed and arrangement indicated and scheduled; each rated to deliver the capacity indicated in the tabulation on the Drawings against the head of the system in which it operates.
- B. Provide each centrifugal pump with an impeller whose diameter is 90% or less of the maximum impeller which the manufacturer shows in his published curves for that pump. Pump selection shall be such that variation of plus or minus 15% of head estimated can be accomplished by "trimming" impellers by the manufacturer.
- C. Impellers shall only be trimmed by manufacturer or an authorized manufacturer's representative.
- D. Efficiencies for the pumps selected for submittal shall be equal to or greater than the efficiency of the scheduled pumps at the scheduled design conditions.
- E. Provide each pump with a constant speed or variable speed (as scheduled), premium efficiency, with minimum efficiencies as listed in Division 23 Common Motor Requirements for HVAC Equipment, ODP motor, unless noted to be a TEFC, wound for operation on the current characteristics indicated in the tabulation on the Drawings. Size each motor with relation to the pump impeller so that the required brake horsepower will not exceed the rated motor horsepower at any point on the pump curve.
- F. Provide pump rated for a continuous water temperature of 225 deg F (107 deg C), unless otherwise indicated.
- G. Provide pump rated for 125 psig (860 kPa) or 250 psig (1720 kPa) as required by its service, unless otherwise indicated. Provide class 125 or 250 flanges to match pump rated service pressure.
- H. Match rating of overcurrent protective device serving the pump assembly. Provide equipment with the available short-circuit current as indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections, unless otherwise indicated.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 - 5. Pump Bearings: Permanently lubricated ball bearings.

- C. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange or flanged connections.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
 - 6. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections unless otherwise indicated.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
 - 5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- C. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor for single speed or an EPDM coupling sleeve for variable-speed applications.
- D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

- E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- F. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.6 AUTOMATIC CONDENSATE PUMP UNITS

- A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

2.7 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 150-psig (1034-kPa) pressure rating, ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support. Unit shall be drilled and tapped for gauge connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results for HVAC."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Pump impellers shall be trimmed when 15% out of scheduled duty.
- C. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- F. Set base-mounted pumps on concrete foundation with anchor-bolt inserts cast into bases. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
- G. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and throttling or triple-duty valve on discharge side of pumps as indicated on drawings. For VFD pumps, a balancing or combination valve is not required.
- F. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps as indicated on drawings.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves. Piping disassembly shall not be required to service pump.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Install suction diffusers for end suction pumps, except condenser water service.
- J. Install check valve and gate or ball valve on each condensate pump unit discharge.
- K. Install electrical connections for power, controls, and devices.
- L. Install each VFD scheduled according to Division 26 Section "Variable Frequency Motor Controllers"
- M. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- N. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 232213

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following for LP and HP steam and condensate piping:
 - 1. Pipe and fittings.
- B. Related Sections include the following:
 - 1. Division 23 Section "Steam Condensate Pumps" for pumps and accessories for steam piping.
 - 2. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
 - 4. Division 23 Section "Hydronic Piping" for near atmospheric pressure condensate piping.
 - 5. Division 23 Section "HVAC Insulation" for insulation and pipe saddles at pipe hangers.
 - 6. Division 23 Section "Steam and Condensate Piping Specialties" for steam valves, flash tanks, traps, and other accessories.
 - 7. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 DEFINITIONS

- A. FMS: Facility Management System.
- B. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.
- C. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.3 ACTION SUBMITTALS

- A. Product Data. Include data on pipe materials, pipe fittings, and applications.
- B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.

- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance:
 - a. Comply with ASME B31.1, "Power Piping" for HP systems for materials, products, and installation.
 - b. Comply with ASME B31.9, "Building Services Piping" for LP systems for materials, products, and installation.
 - c. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - d. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. All underground distribution systems shall be designed in strict conformance to the latest edition of ANSI B31.1 or local requirements, whichever is more stringent, and sealed by a Registered Professional Engineer in good standing with state and local authorities. The system shall be designed to compensate for stresses and movement of the service pipe.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.
- C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

- E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
- I. Stainless-Steel Bellows, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
 - 2. End Connections: Threaded or flanged to match equipment connected.
 - 3. Performance: Capable of 3/4-inch misalignment.
 - 4. CWP Rating: 150-psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
 - 1. Available Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Hart Industries, International Inc.
 - c. Watts Water Technologies, Inc.
 - d. Zurn Plumbing Products Group.
 - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges:
 - 1. Available Manufacturers:
 - a. Capitol Manufacturing Company.
 - b. Watts Water Technologies, Inc..
 - 2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits:
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
 - 2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

- A. LP Steam Piping, aboveground, NPS 2 and Smaller: Standard weight, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- B. LP Steam Piping, aboveground, NPS 2-1/2 and Larger: Standard weight, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

- C. LP Steam Piping, aboveground, NPS 14 and larger: Standard weight, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 CONDENSATE PIPING APPLICATIONS

- A. Condensate piping, aboveground, NPS 2 and smaller, shall be the following: Extra-strong, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- B. Condensate piping, aboveground, NPS 2-1/2 and larger, shall be the following: Extra-strong, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. Condensate Piping, belowground: Pre-insulated piping system with service pipe as described above.

3.3 ANCILLARY PIPING APPLICATIONS

- A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- B. Air-Vent Piping:
 - 1. Inlet: Same as service where installed.
 - 2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.
- C. Vacuum-Breaker Piping: Outlet, same as service where installed.
- D. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
- M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- R. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- S. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
 - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 100 feet.
 - 2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

3.6 HANGERS AND SUPPORTS

- A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.7 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- E. Install a drip leg at coil outlet.

3.9 FIELD QUALITY CONTROL

- A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- B. Perform the following tests on steam and condensate piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
 - 3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
- C. Prepare written report of testing.

END OF SECTION

SECTION 232216

STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following piping specialties for low (LP) pressure steam and condensate piping:
 - 1. Strainers.
 - 2. Safety valves.
 - 3. Thermostatic air vents and vacuum breakers.

1.2 DEFINITIONS

- A. FMS: Facility Management System.
- B. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.
- C. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following, noting the service for each:
 - 1. Air vent and vacuum breaker.
- B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance:
 - a. Comply with ASME B31.1, "Power Piping" for HP systems for materials, products, and installation.

- b. Comply with ASME B31.9, "Building Services Piping" for LP systems for materials, products, and installation.
 - c. Safety valves and pressure vessels shall bear the appropriate ASME label.
 - d. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
- 1. LP Steam and Condensate Piping: 15.0 psig or less.
 - 2. Makeup-Water Piping: Identical to domestic water piping.
 - 3. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 - 4. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Stop-Check Valves:
- 1. Manufacturers:
 - a. A.Y. McDonald Mfg. Co.
 - b. Crane; Crane Energy Flow Solutions.
 - c. Jenkins Valves.
 - d. Lunkenheimer Valves.
 - 2. Body and Bonnet: Malleable iron.
 - 3. End Connections: Flanged.
 - 4. Disc: Cylindrical with removable liner and machined seat.
 - 5. Stem: Brass alloy.
 - 6. Operator: Outside screw and yoke with cast-iron handwheel.
 - 7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
 - 8. Pressure Class: 250.

2.3 STRAINERS

- A. Strainer Perforations: All strainer baskets shall be stainless steel and sized based on the service and installed pipe size as indicated by the table below, unless indicated otherwise.

B. SERVICE DUTY	C. PIPE SIZE (NPS)	D. STRAINER PERFORATION SIZE (in)
E. STEAM	F. 1/4" TO 2"	G. 0.020
	H. 2-1/2" TO 4"	I. 0.031
	J. 6" AND GREATER	K. 0.250

L. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Tapped blowoff plug.
4. CWP Rating: 250-psig working steam pressure.

M. Basket Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. CWP Rating: 250-psig working steam pressure.

2.4 SAFETY VALVES

A. Bronze or Brass Safety Valves, NPS 2-1/2 inches and smaller: ASME labeled.

1. Manufacturers:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve.
 - c. Spirax Sarco, Inc.
 - d. Watts; a Watts Water Technologies company.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves, NPS 1-1/2 inches through NPS 6 inches: ASME labeled.

1. Manufacturers:
 - a. Armstrong International, Inc.

- b. Kunkle Valve.
 - c. Spirax Sarco, Inc.
 - d. Watts; a Watts Water Technologies company.
2. Disc Material: Forged copper alloy with bronze nozzle.
 3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
 4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 5. Pressure Class: 250.
 6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
 7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
 8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.5 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Available Manufacturers:
 - a. Armstrong International, Inc.
 - b. Dunham-Bush, Inc.
 - c. Hoffman Specialty; Division of ITT Industries.
 - d. Spirax Sarco, Inc.
 - e. Sterling.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 1.5x the system to which it is attached.
7. Maximum Temperature Rating: 1.5x the system to which it is attached.

B. Vacuum Breakers:

1. Available Manufacturers:
 - a. Armstrong International, Inc.
 - b. Dunham-Bush, Inc.
 - c. Hoffman Specialty; Division of ITT Industries.
 - d. Johnson Corporation (The).
 - e. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: 1.5x the system to which it is attached.
7. Maximum Temperature Rating: 1.5x the system to which it is attached.

2.6 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Manufacturers:
 - a. Duraflex, Inc.
 - b. Flexicraft Industries.
 - c. Hyspan Precision Products, Inc.
 - d. Mason Industries, Inc.
 - e. Metraflex Company (The).
2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. Pressure Rating: 1.5x the system to which it is attached.
6. Maximum Temperature Rating: 1.5x the system to which it is attached.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code.
- C. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 PIPING INSTALLATION

- A. Select system components with pressure rating equal to or greater than system operating pressure.
- B. Install piping to permit valve servicing.
- C. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- E. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- F. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

- G. Install shutoff valve immediately upstream of each dielectric fitting.
- H. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.3 SAFETY VALVE INSTALLATION

- A. Install safety valves according to ASME B31.1, "Power Piping" or ASME B31.9, "Building Services Piping," based on the service installed.
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.4 HANGERS AND SUPPORTS

- A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.5 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- E. Install a drip leg at coil outlet.

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SECTION 232300
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

B. Related Sections:

1. Division 23 Section "Common Work Results" for description of concrete bases used as vibration isolation.
2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for installation locations of pipe saddles at pipe hangers.
3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
4. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
5. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

- a. Thermostatic expansion valves.
- b. Solenoid valves.
- c. Hot-gas bypass valves.
- d. Filter dryers.
- e. Strainers.
- f. Pressure-regulating valves.

B. Shop Drawings:

1. Delegated-Design Submittal: As a 1/8 inch equals 1 foot scale drawing, show:
 - a. Layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, as well as slopes of horizontal runs.
 - b. Valve arrangements and locations.
 - c. Oil traps.
 - d. Double risers.
 - e. Wall and floor penetrations.
 - f. Equipment connection details.

2. Indicate elevation difference between compressor and evaporator, refrigerant flows, and other information to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
 1. Suction Lines for Air-Conditioning Applications: 115 psig.
 2. Suction Lines for Heat-Pump Applications: 225 psig.
 3. Hot-Gas and Liquid Lines: 225 psig.
- B. Line Test Pressure for Refrigerant R-407C:
 1. Suction Lines for Air-Conditioning Applications: 230 psig.
 2. Suction Lines for Heat-Pump Applications: 380 psig.
 3. Hot-Gas and Liquid Lines: 380 psig.
- C. Line Test Pressure for Refrigerant R-410A:
 1. Suction Lines for Air-Conditioning Applications: 300 psig.

2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube:
 1. ASTM B 88, Type K or L
 2. ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 2. End Connections: Socket ends.
 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 4. Working Pressure Rating: Factory test at minimum 500 psig.
 5. Maximum Operating Temperature: 250 deg F.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as selected in piping application articles.
- B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
- C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Flanged Unions:
 1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
 2. Gasket: Fiber asbestos free.
 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
 5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 6. Pressure Rating: Factory test at minimum 400 psig.

7. Maximum Operating Temperature: 330 deg F.

F. Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket.
2. End Connections:
 - a. NPS 2 and Smaller: With threaded-end connections.
 - b. NPS 2-1/2 and Larger: With flanged-end connections.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.4 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. End Connections: Socket, union, threaded, or flanged.
6. Maximum Opening Pressure: 0.50 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.

2. Core: Removable ball-type check valve with stainless-steel spring.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Copper spring.
 5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Manufacturers:
 - a. Danfoss Inc.
 2. Emerson Climate Technologies.
 3. Paul Mueller Company.
 4. Body and Bonnet: Plated steel.
 5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 6. Seat: Polytetrafluoroethylene.
 7. End Connections: Threaded.
 8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24, 115, or 208-V ac coil.
 9. Working Pressure Rating: 400 psig.
 10. Maximum Operating Temperature: 240 deg F.
- F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Seat: Polytetrafluoroethylene.
 4. End Connections: Threaded.
 5. Working Pressure Rating: 400 psig.
 6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Nonadjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 450 psig.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Equalizer: Internal.
 7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 24, 115, or 208-V ac coil.

8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.

6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

N. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with AHRI 495.

1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.5 REFRIGERANTS

- A. ASHRAE 34, R-134a: Tetrafluoroethane.
- B. ASHRAE 34, R-407C: Difluoromethane / Pentafluoroethane / 1,1,1,2-Tetrafluoroethane.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT

- A. Unless otherwise required by the manufacturer or applicable codes, provide the following for all applications including suction, hot gas, and safety piping:
 1. Aboveground Locations:
 - a. Sizes up to NPS 3/4: ACR, soldered with wrought copper fittings.
 - b. Sizes greater than NPS 3/4 to NPS 4: Type K, brazed with wrought copper fittings.
 - c. Sizes above NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

2. Belowground Locations

- a. Sizes up to NPS 4: Type K, brazed with wrought copper fittings.
- b. Sizes above NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.

- M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping adjacent to machines to allow service and maintenance.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- J. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels where valves or equipment requiring maintenance is concealed behind finished surfaces.
- K. Install refrigerant piping in protective conduit where installed belowground.
- L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- M. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- N. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- O. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.

2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves according to Division 23Section, "Identification for HVAC Piping and Equipment."
- R. Install sleeve seals for piping penetrations of concrete exterior walls and slabs, interior walls, ceilings, and floors. Comply with requirements for sleeve seals specified in Division 23Section "Common Work Results."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23Section "Common Work Results."

3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round, and flat-oval spiral-seam ducts and formed fittings.
 - 3. Double-wall, round, and flat-oval spiral-seam ducts and formed fittings.
 - 4. Duct liner.
- B. Related Sections include the following:
 - 1. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset FRP ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
 - 2. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
 - 3. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 4. Division 23 Section "Breechings, Chimneys, and Stacks".
 - 5. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
 - 6. Division 23 Section "Air Duct Accessories" for fire and smoke
 - 7. Division 07 Section "Penetration Firestopping" for firestopping materials and installation methods.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. NUSIG: National Uniform Seismic Installation Guidelines.

1.3 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings: CAD-generated and drawn to same scale as contract drawings, minimum 1/8 inch equals 1 foot scale. Show fabrication and installation details for metal ducts.

1. Shop drawings required for all areas of the building
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Duct sizes shown on the drawings are net free area and indicate design intent. When obstructions occur within the duct from motorized actuators, damper frames, duct liner, etc., the duct size shall be increased to preserve free area design intent. Duct layout indicating the following:
 - a. Sizes and pressure classes.
 - b. Elevations of top and bottom of ducts.
 - c. Dimensions of main duct runs from building grid lines.
 - d. Fittings.
 - e. Duct accessories, including access doors and panels.
 - f. Notes indicating deviations from design intent for detailed review by Engineer.
4. Equipment installation based on equipment being used on Project.
5. Submit the following with the initial shop drawing package:
 - a. Reinforcement and spacing.
 - b. Seam and joint construction.
 - c. Penetrations through fire-rated and other partitions.
 - d. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
 - e. Dampers
 - 1) Locations of fire-smoke dampers.
 - 2) Locations of motorized control dampers.
 - 3) Indication of location, size, and quantity of damper actuators in the air stream.
 - 4) Location of damper actuator access for maintenance and inspection.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings are required for all areas and shall remain on site. Coordinate with all trades.
- B. Welding certificates.
- C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
3. NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. After fabrication and before the ductwork is installed it shall be "wiped clean" and "heat-shrink wrapped" or some other method of wrap for maintaining a clean ductwork system during delivery to and storage at the jobsite.
- B. Deliver ducts with all openings protected and sealed. Maintain covered openings through shipping, storage, and handling to prevent entrance of dirt, debris, and moisture.
- C. The area provided for duct storage at the jobsite shall be clean, dry and exposure to dust minimized.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view and minimum 26 gage thickness.
- C. Stainless Steel: ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and for exposed ducts.
- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 1. Manufacturers:
 - a. CertainTeed Corp.; Insulation Group.
 - b. Johns Manville International, Inc.

- c. Knauf Fiber Glass GmbH.
 - d. Owens Corning.
 - 2. One inch thick, 1½ pound maximum density, Johns-Manville Permacote Linacoustic or equivalent, glass fiber duct liner having a minimum effective "K" value of 0.24 at 75°F, a roughness (e) factor of 0.0008 feet and sound absorption coefficients as published for that material. The duct liner shall conform to the requirements of ASTM C 1071, with an NRC not less than 0.65 as tested per ASTM C423 using a Type 'A' mounting and a thermal conductivity no higher than 0.25 at 75°F mean temperature. The material and coatings shall comply with the flame spread, fuel contributed and smoke developed ratings of NFPA 90A as tested in accordance with UL-723 and shall meet Life Safety Standards as established by NFPA 90A and 90B. The coating shall contain an EPA Registered immobilized anti-microbial agent and shall be rated to avoid erosion at 5000 fpm velocity (and tested at 12,500 fpm velocity). All edges shall be treated with factory-applied edge coating.
- B. Flexible Elastomeric Duct Liner: Comply with NFPA 90A or NFPA 90B.
- 1. Manufacturers:
 - a. Armstrong World Industries, Inc.
 - b. K-flex.
 - 2. Materials: Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
 - a. Thickness: 1 inch.
 - b. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature.
 - c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
 - d. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - 3. Liner shall be utilized in supply, exhaust, and return ducts as indicated.

2.3 DUCT FIRE WRAP

- A. Fire wrap: An assembly providing at least a 2-hour fire rating for sheet metal ducts.
- B. Manufacturers:
 - 1. Pabco.
 - 2. Unifrax: FyreWrap.
- C. Quality Assurance: Comply with NFPA 96 and U.L. standards.
- D. Where permitted by local codes, the products above may be a substitute for a 2-hour fire rated gypsum board covering.

2.4 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

- B. Joint and Seam Tape: 2 inches wide; glass-fiber-reinforced fabric.
- C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
 - 2. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.6 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, metal cleat, and gasket details.
 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 1. Manufacturers:
 - a. McGill AirFlow Corporation.
 - b. SEMCO Incorporated.
 - c. Spiral Pipe of Texas
 - d. Lewis & Lambert
 - e. Gowco, Inc.
 - f. Spiramir
- C. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 1. Manufacturers:
 - a. McGill AirFlow Corporation.
 - b. SEMCO Incorporated.
 - c. Spiral Pipe of Texas
 - d. Lewis & Lambert
 - e. Gowco, Inc.
 - f. Spiramir
- D. Duct Joints:
 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.

2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
 - a. Manufacturers:
 - 1) Ductmate Industries, Inc.
 - 2) McGill AirFlow Corporation.
 - 3) SEMCO Incorporated.
- E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging-Flow Fittings: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die-formed, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
 1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
 - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
 - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
 - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
 4. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only.
 5. Round Elbows Larger Than 9 Inches in Diameter: Fabricate pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows.
 6. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
 7. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.
- H. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Round Elbows 28 to 60 Inches in Diameter: Standard welded construction.
4. Other Fittings: Welded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.8 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Manufacturers:

1. McGill AirFlow Corporation.
2. SEMCO Incorporated.

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch-thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
 - a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
 - b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
 - c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
 - d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.
4. Perforated Inner Ducts: Fabricate with 0.028-inch-0.7-mm- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:
 - a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
 - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
 - c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
2. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Primary Supply Ducts (before Air Terminal Units): 3-inch wg
 - 2. Secondary Supply Ducts (after Air Terminal Units): 2-inch wg.
 - 3. Return Ducts (Negative Pressure): 2-inch wg.
 - 4. Exhaust Ducts (Negative Pressure): 3-inch wg.
 - 5. All other ducts: 2.5 inch wg (750 Pa), positive or negative based on service.
- B. All ducts shall be galvanized steel except as follows, unless otherwise indicated:
 - 1. Range Hood Exhaust Ducts: Comply with NFPA 96.
 - a. Concealed: Carbon-steel sheet.
 - b. Exposed: Type 304, stainless steel with finish to match kitchen equipment and range hood.
 - c. Fully weld all seams and joints.
 - 2. Wet Exhaust Service Ducts:
 - a. Construction:
 - 1) Type 304, stainless steel with finish to match kitchen equipment and range hood. Fully weld all seams and joints.
 - 2) Aluminum, soldered with seams and laps arranged on top of duct.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install ducts with fewest possible joints.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Install duct liner in exhaust and return ducts from equipment inlet connection to 25'-0"upstream of inlet, minimum.

- I. Provide break away flange for all stainless steel ductwork at fire/smoke damper interfaces. Install stainless steel drain pans extending beyond in all directions with automatic condensate pumps and piping to nearest code approved drain at break away.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- L. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- M. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- O. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant.
- P. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems.", unless otherwise indicated.
- Q. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."
- R. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections. Painting not required for ducts serving mechanical, electrical and data rooms.
- S. Provide concrete pipe curb in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level.
- T. Provide temperature range for duct mounted thermometer dials: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.3 INSTALLATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with complete adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

- E. Do not apply liner with longitudinal joints in rectangular ducts, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
- G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - 1. Fan discharges.
 - 2. Intervals of lined duct preceding unlined duct.
 - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.
- I. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
- J. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

3.4 SPECIAL INSTALLATION REQUIREMENTS FOR SPECIAL EXHAUST APPLICATIONS

- A. Wet Exhaust Ducts:
 - 1. Exhaust ductwork shall be all welded construction suitable for a negative or positive pressure of 2" w.c. All seams and joints shall be watertight.
 - a. Concealed duct: 24 gage all welded aluminum or 18 gage stainless steel, minimum.
 - b. Exposed duct: 18 stainless steel gage with a #4 finish. All seams ground and polished.
 - 2. Ductwork shall be sloped toward the dishwasher connections at 1/8" per linear foot, minimum.
 - 3. Locations required:
 - a. Central sterile washing equipment.
 - b. Sterilizer exhaust services.

3.5 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for ducts, per Seal Class 'A'.
- B. Seal ducts before external insulation is applied.

3.6 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Support Ducts per SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for ducts.
- F. Do not use powder-actuated concrete fasteners

3.7 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 FIELD QUALITY CONTROL

- A. The leak testing shall be observed by the General Contractor's representative and the Owner's representative. Provide 48 hours notification of such tests.
- B. All ducts shall be tested. Submit a written report. The contractor is required to maintain on-site a set of ductwork prints that are shaded in different colors to show the duct section isolated for each test. Also the Contractor shall indicate on the print the date each section of duct was tested and the final percent leakage rate measured for each test section.
- C. If any duct section fails the leakage test, the contractor shall repair the leakage and re-perform the leakage test.
- D. The duct systems shall be pressure tested for leaks at their specified pressure ratings and shall be within the maximum allowed by the following:
 - 1. Primary Air (medium pressure ducts) Systems – 3% leakage.
 - 2. Other Systems – 2% leakage.
- E. The leakage test shall be performed using a kit as furnished by United McGill Corp. or approved equal and shall include the following components:
 - 1. Blower
 - 2. Two manometers or U-tubes
 - 3. Calibrated orifice tube
- F. The leakage test procedure is as follows:

1. Carefully seal off all openings (except one for connecting the test equipment) to the duct run-out section to be tested.
2. Connect the downstream end of the orifice tube to the duct system using a piece of flexible tubing.
3. Connect one manometer to the static taps on the tube to read orifice differential pressure. Connect the other manometer to a 5/16" tap in the duct at least one foot from the blower connection to read test static pressure.
4. Attach the blower to the orifice tube and block off the inlet to prevent over pressurizing a tight system.
5. Start the blower and slowly open the inlet until the desired test static pressure is reached. Let the blower run for at least one minute to insure a steady state.
6. At this point, the air flowing through the orifice tube is going into the duct system and is equal to the amount leaking out. This leakage rate can be read from the calibration chart on the orifice tube. This measured cfm is used to determine the leakage percent.
7. If the duct system is too large and the allowable leakage is greater than the capacity of the blower, the system shall be tested in several sections and the results added together.

3.9 DUCT CLEANLINESS AND DUCT CLEANING

1. DUCT CLEANLINESS

- a. It is the intent to provide an installation of a ductwork system that appears to be visibly clean.
- b. A visual inspection of porous and non-porous ductwork components must be monitored by the Contractor to ensure that the system is visibly clean. The system has excessive dust or debris when an accumulation of particles can be observed in the ductwork. An interior surface is considered visibly clean when it is free from non-adhered substances and debris.
- c. Cleanliness verification shall be performed after the ductwork system has been "wiped clean" and prior to the application of any piece of equipment or component being used in operation.
- d. If air handling units are operated without the pre-filters and the final filters in place, the ductwork shall be replaced or vacuumed per Article B "Cleaning New Systems" below.

2. Condition of new ductwork shall include the following measures:

- a. Any internal exposed mastic sealant to be removed.
- b. The light coating of oil on machine formed sheet metal ductwork is to be removed.
- c. The discoloration marks from the plasma cutting process must be removed.
- d. Before installation of the individual duct sections they are to be visually inspected for dust and/or debris, and wiped clean, if necessary.
- e. After the ductwork has been installed, the cleanliness procedure shall be to temporarily cover the open ends of the ductwork to prevent dust and debris of finding its way to the system.
- f. If vacuuming is required to adequately clean the ductwork, the vacuum cleaner must be HEPA filtered and capable of achieving a minimum of 40 inches of water gage. The vacuum should be fitted with a 2.5" round nylon brush attached to a 1.5" diameter vacuum hose.

3. Conditions of existing ductwork and equipment within the systems that serve the renovated areas shall be visually inspected for dust and debris.

- a. If dust and/or debris is observed within the existing system, it shall be cleaned to remove all visual dust and debris. This process may include the addition of access doors to facilitate the "wiping" and/or "vacuuming" of the ductwork systems.
- b. The system cleanliness procedures shall be adhered to during the construction process of the renovations.
- c. New ductwork required for additions within the existing renovated area shall follow the procedures addressed above for the new ductwork.
- d. If vacuuming is required to adequately clean the ductwork, the vacuum cleaner must be HEPA filtered and capable of achieving a minimum of 40 inches of water gage. The vacuum should be fitted with a 2.5" round nylon brush attached to a 1.5" diameter vacuum hose.

B. CLEANING NEW SYSTEMS

- 1. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- 2. Use service openings, as required, for physical and mechanical entry and for inspection.
 - a. Create other openings to comply with duct standards.
 - b. Disconnect flexible ducts as needed for cleaning and inspection.
 - c. Remove and reinstall ceiling sections to gain access during the cleaning process.
- 3. Vent vacuuming system to the outside. Include HEPA filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
- 4. Clean the following metal duct systems by removing surface contaminants and deposits:
 - a. Air outlets and inlets (registers, grilles, and diffusers).
 - b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - d. Coils and related components.
 - e. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
 - f. Supply-air ducts, dampers, actuators, and turning vanes.
- 5. Mechanical Cleaning Methodology:
 - a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - d. Do not permit fibrous-glass duct liner to get wet. Remove and replace wet duct liner.
 - e. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
- 6. Cleanliness Verification:

- a. Visually inspect metal ducts for contaminants.
- b. Where contaminants are discovered, re-clean and reinspect ducts.

C. CLEANING EXISTING SYSTEMS

1. Use service openings, as required, for physical and mechanical entry and for inspection.
 - a. Use existing service openings where possible.
 - b. Create other openings to comply with duct standards.
 - c. Disconnect flexible ducts as needed for cleaning and inspection.
 - d. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
 - e. Remove and reinstall ceiling sections to gain access during the cleaning process.
2. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.
3. Particulate Collection and Odor Control:
 - a. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
 - b. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.
4. Clean the following metal duct systems by removing surface contaminants and deposits:
 - a. Air outlets and inlets (registers, grilles, and diffusers).
 - b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - d. Coils and related components.
 - e. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
 - f. Supply-air ducts, dampers, actuators, and turning vanes.
 - g. Dedicated exhaust and ventilation components and makeup air systems.
5. Mechanical Cleaning Methodology:
 - a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - e. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - f. Provide operative drainage system for washdown procedures.

- g. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.
- 6. Cleanliness Verification:
 - a. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
 - b. Visually inspect metal ducts for contaminants.
 - c. Where contaminants are discovered, re-clean and reinspect ducts.
- 7. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
 - a. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
 - b. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.
- 8. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Ceiling fire dampers.
6. Smoke dampers.
7. Combination fire and smoke dampers.
8. Duct silencers.
9. Electric Duct Heaters.
10. Turning vanes.
11. Duct-mounting access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

B. Related Sections include the following:

1. Division 23 Section "Instrumentation and Control for HVAC" for electric and pneumatic damper actuators.
2. Division 23 Section "Metal Ducts" for duct construction and fittings.
3. Division 28 Section "Fire Detection and Alarm" for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS

- A. Low Leakage: Class 1A as defined by AMCA Standard 511, equating to less than 3cfm/ft² of damper area, at differential pressure of 1-inch wg less than 8cfm/ft² of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Ceiling fire dampers.
6. Smoke dampers.

7. Combination fire and smoke dampers.
8. Duct silencers.
9. Turning vanes.
10. Duct-mounting access doors.
11. Flexible connectors.
12. Flexible ducts.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Special fittings.
2. Manual-volume damper installations.
3. Motorized-control damper installations.
4. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
5. Identify duct velocity and pressure class of duct system dampers are installed in.
6. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fusible Links: Furnish quantity equal to 10 percent, rounding up, for each type of amount installed with a minimum of one.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M.

- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. Duro Dyne Corp.
 - 4. Greenheck.
 - 5. Loren Cook.
 - 6. Penn Ventilation Company, Inc.
 - 7. Pottoroff.
 - 8. Prefco Products, Inc.
 - 9. Ruskin Company.
 - 10. Vent Products Company, Inc.
- B. Description: Multiple or single-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- C. Frame: Extruded aluminum, with welded corners and mounting flange.
- D. Blades: 0.050-inch-thick aluminum sheet.
- E. Blade Seals: Neoprene.
- F. Blade Axles: Nonferrous.
- G. Tie Bars and Brackets: Aluminum.
- H. Return Spring: Adjustable tension.

2.3 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. Flexmaster U.S.A., Inc.
 - 4. McGill AirFlow Corporation.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.

7. National Controlled Air.
 8. Penn Ventilation Company, Inc.
 9. Pottoroff.
 10. Ruskin Company.
 11. Vent Products Company, Inc.
 12. Young Regulator Company.
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
 2. Dampers integral to building envelope shall be AMCA 511 Class 1 rated, minimum.
- C. Duct Dampers.
1. Standard Volume:
 - a. Multiple- or single-blade, parallel- or opposed-blade design, AMCA 511 Class 2 rated, with linkage outside airstream, and suitable for horizontal or vertical applications. Blade and frame materials shall match.
 - b. Steel:
 - 1) Frames: Hat-shaped, galvanized sheet steel channels, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2) Roll-Formed Blades: Galvanized sheet steel.
 - c. Aluminum
 - 1) Frames: Hat-shaped, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 - 2) Roll-Formed Blades: 0.10-inch-thick aluminum sheet.
 - 3) Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 - d. Blade Axles: Galvanized steel.
 - e. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve.
 - f. Tie Bars and Brackets: Galvanized Steel.
 2. Low-Leakage Volume:
 - a. Multiple-blade, parallel- or opposed-blade design as indicated, AMCA 511 Class 1A rated, with linkage outside airstream, and suitable for horizontal or vertical applications. Blade and frame materials shall match.
 - b. Steel:
 - 1) Frames: Hat, U-, or angle-shaped, galvanized sheet steel channels, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2) Roll-Formed Blades: 0.064-inch-thick, galvanized sheet steel.

c. Aluminum:

- 1) Frames: Hat, U-, or angle-shaped, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
- 2) Roll-Formed Blades: 0.10-inch-thick aluminum sheet.
- 3) Extruded Blades: 0.050-inch-thick extruded aluminum.

d. Blade Axles: Galvanized steel.

e. Bearings: Oil-impregnated bronze or stainless-steel sleeve thrust or ball.

f. Blade Seals: Vinyl or Neoprene.

g. Jamb Seals: Cambered aluminum.

h. Tie Bars and Brackets: Galvanized steel.

3. Remote Mounted:

- a. Rack-and-pinion controller fabricated from minimum 14 gage galvanized steel with graduations for positive locking control.
- b. Control cable shall be .054" stainless steel in 1/16" flexible galvanized casing.

D. Duct Tap-Offs

1. Duct tap offs from rectangular or round duct are round, conical connector, with spin-in or twist-in collar, and integral damper. Include bead from using mechanical strap.
2. Side taps, consisting of an eccentric wedge pointing into the flow narrowing to a round duct are also acceptable.
3. Construction materials and pressure class shall identical to the attached duct system.

E. Jackshaft: Pipe matching linkage material rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 MOTORIZED CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Duro Dyne Corp.
4. Greenheck.
5. McGill AirFlow Corporation.
6. METALAIR, Inc.
7. Nailor Industries Inc.
8. National Controlled Air.
9. Pottoroff.
10. Penn Ventilation Company, Inc.
11. Ruskin Company.
12. Vent Products Company, Inc.

- B. General Description: Class 1A, AMCA 511, parallel or opposed-blade airfoil design; galvanized-steel frames with holes for duct mounting; galvanized-steel damper blades with maximum blade width of 8 inches.
 - 1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - 2. Operating Temperature Range: From minus 40 to plus 200 deg F.
 - 3. Provide parallel- or opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for low leakage.

2.5 FIRE DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. Greenheck.
 - 3. McGill AirFlow Corporation.
 - 4. METALAIR, Inc.
 - 5. Nailor Industries Inc.
 - 6. National Controlled Air.
 - 7. Penn Ventilation Company, Inc.
 - 8. Pottoroff.
 - 9. Prefco Products, Inc.
 - 10. Ruskin Company.
 - 11. Vent Products Company, Inc.
 - 12. Ward Industries, Inc.
- B. Fire dampers shall be labeled according to UL 555, Class 1.
- C. Fire Rating: 1-1/2 and 3 hours.
 - 1. Type 304, stainless-steel dampers are also available for corrosive atmospheres.
- D. Frame: fabricated with roll-formed galvanized steel; with mitered and interlocking corners.
 - 1. Provide multiple-blade type for dynamic applications.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- F. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, galvanized-steel blade connectors.
- G. Resets:
 - 1. Fusible Links: Replaceable, 165 deg F (74 deg C) rated.

2.6 CEILING FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIR, Inc.
5. Nailor Industries Inc.
6. National Controlled Air.
7. Penn Ventilation Company, Inc.
8. Pottoroff.
9. Prefco Products, Inc.
10. Ruskin Company.
11. Vent Products Company, Inc.
12. Ward Industries, Inc.

B. General Description: Labeled according to UL 555C, Class 1; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Resets:

1. Fusible Links: Replaceable, 165 deg F (74 deg C) rated.

2.7 SMOKE AND COMBINATION FIRE / SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Greenheck.
3. Nailor Industries Inc.
4. National Controlled Air.
5. Penn Ventilation Company, Inc.
6. Pottoroff.
7. Ruskin Company.

B. General Description: Labeled according to UL 555S, Class 1. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Resets:

1. Automatic.

D. Frame and Blades: 0.064-inch-thick, galvanized sheet steel.

E. Mounting Sleeve: Factory-installed galvanized sheet steel; length to suit wall or floor application.

F. Damper Motors: Modulating and two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
4. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at 10 degrees lower than ASHRAE 99.6% Heating DB.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz.

2.8 DUCT SILENCERS

A. Manufacturers:

1. Dynasonics.
2. I.A.C.
3. Industrial Noise Control, Inc.
4. McGill AirFlow Corporation.
5. Ruskin Company.
6. SEMCO.
7. Vibro-Acoustics.

B. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated. Gage and material of casing shall be no less than the requirements of the system served.

C. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.

D. Rectangular Units: Fabricate casings with solid galvanized sheet metal for outer casing and ASTM A 653/A 653M, G90, perforated galvanized sheet metal for inner casing.

E. Round Units:

1. Outer Casings:

- a. ASTM A 653/A 653M, G90, galvanized sheet steel.

2. Interior Casing, Partitions, and Baffles:

- a. ASTM A 653/A 653M, G90, galvanized sheet steel.
- b. At least 0.034 inch thick and designed for minimum aerodynamic losses.

F. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

G. Fill Material: Inert, moisture proof, and vermin-proof material, packed under not less than 5 percent compression.

1. Erosion Barrier:
 - a. Polymer or Tedlar bag enclosing fill and heat-sealed before assembly.
 - b. Mylar layer attached with adhesive between fill and airstream.
- H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.
 1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
 2. Lock form and seal or continuously weld joints.
 3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 4. Reinforcement: Cross or trapeze angles for rigid suspension.
- I. Source Quality Control:
 1. Acoustic Performance: Test according to ASTM E 477.
 2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.9 ELECTRIC DUCT HEATERS

- A. Manufacturers
 1. Bel Thermal Units
 2. Chromalox
 3. Indeeco
 4. Nailor
 5. Warren Products
- B. Description: Slip-in-type, open-coil design with integral control box factory wired and installed. Include the following features:
 1. Primary and secondary over-temperature protection.
 2. Nickel chrome 80/20 heating elements.
 3. Airflow switch.
 4. Noninterlocking disconnect switch.
 5. Fuses (for coils more than 48 A).
 6. Mercury contactors.
 7. Pneumatic-electric switches and relays.
 8. Magnetic contactor for each step of control (for three-phase coils).

2.10 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch-wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Manufacturers:

- a. Ductmate Industries, Inc.
- b. Duro Dyne Corp.
- c. Dynasonics.
- d. I.A.C.
- e. METALAIRE, Inc.
- f. SEMCO.
- g. Ward Industries, Inc.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill, with Mylar or Tedlar wrap around fill.

D. Acoustic Elbows: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill, with Mylar or Tedlar wrap around fill.

2.11 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:

- a. American Warming and Ventilating.
- b. Ductmate Industries, Inc.
- c. Flexmaster U.S.A., Inc.
- d. Greenheck.
- e. McGill AirFlow Corporation.
- f. Nailor Industries Inc.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Provide number of hinges and locks as follows:

- a. Less Than 12 Inches Square: Secure with two sash locks.
- b. Up to 18 Inches Square: Two hinges and two sash locks.
- c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
- d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Manufacturers:

- a. Ductmate Industries, Inc.
- b. Flexmaster U.S.A., Inc.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

- D. Pressure Relief Access Door: Single or double wall and duct mounting; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.
 - 1. Manufacturers:
 - a. American Warming and Ventilating.
 - b. Ductmate Industries, Inc.
 - c. Greenheck.
 - d. KEES, Inc.
 - e. McGill AirFlow Corporation.
 - f. Nexus PDQ.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- F. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.12 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Corp.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with NFPA 90A & 90B.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Select metal compatible with ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd..
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.

- G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd..
 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.

2.13 FLEXIBLE DUCTS

- A. Manufacturers:
1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow Corporation.
 3. Thermaflex.
 4. Wiremold.
- B. Noninsulated Flexible Ducts: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 2. Minimum Air Velocity Rating: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 175 deg F.
- C. Insulated Flexible Ducts: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation with a minimum value of R-6; polyethylene or aluminized vapor barrier film.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 2. Minimum Air Velocity Rating: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 175 deg F.
- D. Metal Lined Insulated Flexible Ducts: UL 181, Class 1, Triple locked aluminum inner core; fibrous glass insulation with a minimum value of R-6.
1. Pressure Rating: 6-inch wg (1500 Pa) positive and 2-inch wg (500 Pa) negative.
 2. Minimum Air Velocity Rating: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 250 deg F
- Insulated Fabric Ducts: UL 181, Class 1, with Chlorinated Polyethylene (CPE) inner core supported by helical wound galvanized steel; fibrous-glass insulation with a minimum R-6 value.
4. Pressure Rating: 6-inch wg (1500 Pa) positive and 2-inch wg (500 Pa) negative.
 5. Minimum Air Velocity Rating: 4000 fpm.
 6. Temperature Range: Minus 20 to plus 250 deg F
- Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap, in sizes 3 through 18 inches to suit duct size.

2.14 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Where damper actuators are located in the air stream, increase duct free area to maintain design intent.
- C. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- E. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- F. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- G. Install duct test holes where indicated and required for testing and balancing purposes.
- H. Install remote dampers a minimum of 5 feet, or two duct diameters, whichever is greater, before air device.
- I. Remote dampers shall include controller box as approved by architect.
- J. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- K. Install fire and smoke dampers, with reset operators or fusible links, according to manufacturer's UL-approved written instructions.
- L. Install duct silencers rigidly to ducts.
- M. Install duct heaters square to duct and perpendicular to air travel. Provide disconnecting means at heater.
- N. Connect duct discharge temperature sensor downstream of duct heater.
- O. Connect controlling thermostat or control cable to duct heater.
- P. Install turning vanes in all square elbows, except for combustion air, dryer vent, and grease duct services, unless otherwise indicated.
- Q. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- R. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- S. Connect terminal units to supply ducts.

- T. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- U. Do not use flexible ducts to change directions.
- V. Connect flexible ducts to metal ducts with draw bands.
- W. Flexible duct may only be installed above hard ceilings with direct access to all both ends of the flexible duct runs. Flexible duct shall not be installed more than 24" inside a hard ceiling edge or transition.

3.2 END SWITCH APPLICATIONS

- A. Install an end switches for each damper:
 - 1. Motorized control damper.
- B. Connect each motorized control damper to the FMS.
- C. Connect each fire and fire/smoke damper to the fire alarm system

3.3 FIRE AND FIRE/SMOKE DAMPER APPLICATIONS

- 1. Unless otherwise indicated, provide dampers according to the following criteria:
 - a. Type-A dampers
 - 1) Pressure: up to 2 inches wg.
 - 2) Velocity: up to 1500 ft/min.
 - 3) Duct dimensions: greater than 14 inches, square.
 - b. Type-B dampers
 - 1) Pressure: up to 8 inches wg.
 - 2) Velocity: up to 3500 ft/min
 - c. Type-C dampers
 - 1) Pressure: greater than 8 inches wg.
 - 2) Velocity: greater than 3500 ft/min.
- 2. Where dampers are required at sidewall grilles, damper shall be Frame Style G for flush installation of air device.
- 3. Damper sleeves may be omitted where not required by the manufacturer's listed assembly, code, or these documents.

3.4 DUCT ACCESS DOOR APPLICATIONS

- A. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.

2. Downstream from volume dampers, motorized dampers, and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.

B. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 8 inches.
2. Two-Hand Access: 12 by 12 inches.
3. Head and Hand Access: 18 by 18 inches.
4. Head and Shoulders Access: 24 by 18 inches.
5. Body Access: 30 by 24 inches.
6. Body Plus Ladder Access: 30 by 24 inches.

C. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.
3. Head and Hand Access: 12 inches in diameter.
4. Head and Shoulders Access: 18 inches in diameter.
5. Body Access: 24 inches in diameter.

D. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.5 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

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SECTION 233400

HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Centrifugal roof ventilators.
4. Forward-curved centrifugal fans.
5. In-line centrifugal fans.
6. Mixed-flow fans.
7. Propeller fans.
8. Utility set fans.

B. Related Sections include the following:

1. Division 03 Sections "Cast-in-Place Concrete" and "Miscellaneous Cast-in-Place Concrete".
2. Division 07 Section "Roof Accessories" for roof curbs, equipment supports, and roof penetrations.
3. Division 23 Section "Air Duct Accessories" for flexible connectors, dampers, etc. are specified in.
4. Division 23 Section "Common Motor Requirements for HVAC" for fan motors.
5. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
6. Division 23 Section "Identification for HVAC Piping and Equipment" for fan label requirements.
7. Division 23 Section "Instrumentation and Controls for HVAC".
8. Division 23 Section "Variable Frequency Drives".
9. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan performance ratings on actual Project site elevations above sea level.
- B. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Fan schedule, by equipment mark, with capacity selections indicating required accessories.

2. Certified fan performance curves with system operating conditions indicated.
 3. Certified fan sound-power ratings.
 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 5. Material thickness and finishes, including color charts.
 6. Dampers, including housings, linkages, and operators.
 7. Fan speed controllers, including, but not limited to, variable speed drives.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.
 2. Short-circuit current rating of equipment assembly. Rating must match the rating of the overcurrent protective device serving the assembly.
 3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 SIMULTANEOUS ACTION SUBMITTALS

- A. HVAC Fan Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study."

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Data to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

- E. Fans shall not exceed 85% of class rating at the selection point.
- F. Sound-Power Level Ratings:
 - 1. Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data."
 - 2. Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans."
 - 3. Label fans with the AMCA-Certified Ratings Seal.
 - 4. Raw sound discharge for fans shall not exceed 95 dB in the 63, 125, and 250 Hz bands.
- G. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final locations, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.9 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

1.11 LABELS

- A. All fans shall have a firmly affixed metal nameplate recording the design air capacity, static pressure, and brake horsepower.

PART 2 - PRODUCTS

2.1 AIRFOIL CENTRIFUGAL FANS

A. Manufacturers:

1. Acme Engineering & Mfg. Corp.
2. Chicago Blower Corporation.
3. Greenheck.
4. Loren Cook Company.
5. New York Blower Company (The).
6. Twin City Fan & Blower.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Air-tight all welded housing construction.
3. Spun inlet cone with flange.
4. Outlet flange.

D. Airfoil Wheels:

1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
2. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
3. Heavy backplate.
4. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
5. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Bearings:

1. Bearing Types:

- a. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
- b. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
- c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

2. Bearing Rating Life:

- a. Ball-Bearings: ABMA 9, L10 at 200,000.
- b. Roller-Bearings: ABMA 11, L10 at 200,000.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

- 1. Service Factor Based on Fan Motor Size: 1.5.
- 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
- 3. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
- 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
- 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- 6. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

- 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
- 2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
- 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
- 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
- 5. Inlet Screens: Grid screen of same material as housing.
- 6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
- 7. Spark-Resistant Construction: AMCA 99.
- 8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
- 9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers:

- 1. Acme Engineering & Mfg. Corp.
- 2. Barry Blower Div.; Penn Ventilation Companies, Inc.
- 3. Chicago Blower Corporation.
- 4. Greenheck.
- 5. Loren Cook Company.
- 6. New York Blower Company (The).
- 7. Twin City Fan & Blower.

- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
 - 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 2. Air-tight all welded housing construction.
 - 3. Spun inlet cone with flange.
 - 4. Outlet flange.
- D. Backward-Inclined Wheels:
 - 1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
 - 2. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
 - 3. Backplate.
 - 4. Backward-inclined blades welded or riveted to flange and backplate.
 - 5. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Bearings:
 - 1. Bearing Types:
 - a. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
 - b. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 2. Bearing Rating Life:
 - a. Ball-Bearings: ABMA 9, L10 at 200,000.
 - b. Roller-Bearings: ABMA 11, L10 at 200,000.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.5.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

- b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
- 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 - 2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
 - 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 - 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 5. Inlet Screens: Grid screen of same material as housing.
 - 6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 - 7. Spark-Resistant Construction: AMCA 99.
 - 8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers:
- 1. Acme Engineering & Mfg. Corp.
 - 2. Carnes Company HVAC.
 - 3. FloAire.
 - 4. Greenheck.
 - 5. Loren Cook Company.
 - 6. Penn Ventilation.
 - 7. Twin City Fan & Blower.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
- 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels:
- 1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
 - 2. Aluminum hub and wheel with backward-inclined blades.

- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- G. Roof Curbs:
1. Factory fabricated; galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 2. Configuration: Self-flashing without a cant strip, with mounting flange.
 3. Overall Height: Coordinate curb height with roofing system for minimum clearances above finished roof deck as follows:
 - a. Supply intake: 36 inches.
 - b. General exhaust discharge: 12 inches.
 4. Pitch Mounting: Manufacture curb for roof slope.
 5. Metal Liner: Galvanized steel.
 6. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 FORWARD-CURVED CENTRIFUGAL FANS

- A. Manufacturers:
1. Acme Engineering & Mfg. Corp.
 2. Chicago Blower Corporation.
 3. Greenheck.
 4. Loren Cook Company.
 5. New York Blower Company (The).
 6. Twin City Fan & Blower.
- B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Air-tight all welded housing construction.
 3. Spun inlet cone with flange.

4. Outlet flange.
- D. Forward-Curved Wheels:
1. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19.
 2. Baked-enamel or galvanized steel construction with inlet flange.
 3. Backplate.
 4. Shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate.
 5. Cast-steel hub swaged to backplate and fastened to shaft with set screws.
- E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Bearings:
1. Bearing Types:
 - a. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
 - b. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Bearing Rating Life:
 - a. Ball-Bearings: ABMA 9, L10 at 200,000.
 - b. Roller-Bearings: ABMA 11, L10 at 200,000.
- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor Size: 1.5.
 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 3. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 6. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.
 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 5. Inlet Screens: Grid screen of same material as housing.
 6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 7. Spark-Resistant Construction: AMCA 99.
 8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers:
1. Acme Engineering & Mfg. Corp.
 2. Carnes Company HVAC.
 3. Greenheck.
 4. Loren Cook Company.
 5. Penn Ventilation.
 6. Twin City Fan & Blower.
- B. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- G. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 3. Companion Flanges: For inlet and outlet duct connections.
 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.6 MIXED-FLOW FANS

- A. Manufacturers:
 - 1. Loren Cook Company.
 - 2. Greenheck.
 - 3. Twin City Fan & Blower.
- B. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt drive, and accessories.
- C. Housings: Galvanized steel.
 - 1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
 - 2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
 - 3. Mixed-Flow Outlet Connection: One flanged discharge(s) perpendicular to fan inlet.
- D. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.
- E. Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.5.
 - 2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Motor Mount: Adjustable base.
 - 7. Shaft Bearings: Radial, self-aligning ball or roller bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000.
 - c. Extend lubrication lines to outside of casing and terminate with grease fittings.
- F. Accessories:
 - 1. Mounting Clips: Clips welded to fan housing, of same material as housing.
 - 2. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork of same material as housing.
 - 3. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
 - 4. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
 - 5. Outlet Cones: Round-to-round transition of same material as housing.
 - 6. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
- G. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Retain coatings for special protection applications. Review manufacturer's data for specific trade names and literature.
4. Coatings: Powder-baked enamel.
 - a. Apply to finished housings.
 - b. Apply to fan wheels.

2.7 PROPELLER FANS

A. Manufacturers:

1. Acme Engineering & Mfg. Corp.
2. Carnes Company HVAC.
3. Chicago Blower Corporation.
4. Greenheck.
5. Loren Cook Company.
6. New York Blower Company (The).
7. Penn Ventilation.
8. Twin City Fan & Blower.

B. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Fan Wheels:

1. Steel: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
2. Aluminum: Replaceable, cast or extruded, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.4.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000.
4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

7. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Motorized Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.8 UTILITY SET FANS

A. Manufacturers:

1. Barry Blower.
2. Greenheck.
3. Loren Cook Company.
4. New York Blower Company (The).
5. Penn Ventilation.
6. Twin City Fan & Blower.

- B. Description: Direct or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

- C. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

- D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel or Aluminum.
2. Blade Type: Backward inclined, forward curved, airfoil.
3. Spark-Resistant Construction: AMCA 99, Type B.

E. Fan Shaft:

1. Turned, ground, and polished steel; keyed to wheel hub.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

- F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9 L10 at 200,000.

- G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.5.
 2. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
 3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- H. Accessories:
1. Inlet and Outlet: Flanged.
 2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 3. Access Door: Gasketed door in scroll with latch-type handles.
 4. Inlet Screens: Removable wire mesh.
 5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
 6. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
- I. Coatings: Powder-baked enamel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans level and plumb.
- B. Equipment shall be supported as described in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment".
- C. Secure roof mounted fans to roof curbs with cadmium-plated hardware.
- D. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

- A. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in duct systems.
- B. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- C. Install ducts adjacent to fans to allow service and maintenance.
- D. For fans with scroll drains, install line-sized piping from drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Replace fan and motor pulleys as required to achieve design airflow.
 - 11. Shut unit down and reconnect automatic temperature-control operators.
 - 12. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fans. Refer to Division 01 Section "Demonstration and Training."

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SECTION 233600

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Dual-duct air terminal units.
2. Fan-powered air terminal units.
3. Shutoff single-duct air terminal units.
4. Air valves.

B. Related Sections include the following:

1. Division 23 Section "Hydronic Piping".
2. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
3. Division 23 Section "Instrumentation and Control for HVAC".

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
2. Wiring Diagrams: Power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- D. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- E. Verification of Performance: Rate air terminal units according to ARI 880.

1.6 COORDINATION

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Enviro-tec.
 - 2. Kreuger.
 - 3. METALLAIRE, Inc.; Metal Industries Inc.
 - 4. Nailor Industries.
 - 5. Phoenix Corporation.
 - 6. Price Industries.
 - 7. Titus.

2.2 GENERAL

- A. Provide factory mounted Andover controls package.
- B. Terminal units shall not exceed NC 26 at 3" w.g. per AHRI 880.
- C. Terminals with hydronic reheat shall implement two PID loops, one with the zone temperature as the input and the second one with the box DAT as input.

2.3 UNIT CONTROLS

- A. Factory-Mounted and -Wired Controls: Electrical components including, differential pressure sensor and air flow sensing tubes, shall be mounted in NEMA 250, Type 1 control box with removable cover, mounted on side of unit and sealed from airflow. Incorporate single-point electrical connection to power source.
 - 1. Control Transformer: Factory mounted for 24 VAC control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source. Units with fans shall also require fan start/stop relay.
 - 2. Wiring Terminations: Fan and controls to terminal strip, and terminal lugs shall match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 - 3. Primary air Belimo damper actuator and Andover's pressure independent primary air controller.
 - 4. Airflow sensing tubes:
 - a. Sensing tubes of the multipoint, automatic averaging type shall be included in each unit inlet.
 - b. Dual-duct units shall have airflow sensing tubes at the unit outlet.
 - c. Airflow sensing tubes are to include 'tees' utilized as balancing taps for field adjustment of the maximum (and minimum) primary CFM, without having to remove tubes from controller.
 - d. The balancing taps shall be used in conjunction with a flow chart on each terminal unit to permit readjustment of the primary air. Field readjustment shall be by means of adjustment screws.
 - 5. A schematic drawing shall be affixed to each box indicating proper hookups for electronic thermostats.
- B. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 23 Section "Instrumentation and Control for HVAC" and shall have the following features:
 - 1. Damper Actuators: 24 V, powered open.
 - 2. Velocity Sensors: Multipoint array with velocity sensors in all air inlets and air outlet and integral to unit.
 - 3. Terminal Unit Controller: Pressure independent, variable-air or constant-volume controller with electronic airflow transducers factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Proportional, plus integral control of room temperature.
 - b. Time-proportional reheat-coil control.
 - c. Occupied and unoccupied operating mode.
 - d. Remote reset of airflow or temperature set points.

- e. Adjusting and monitoring with portable terminal.
- f. Communication with temperature-control system specified in Division 23Section "Instrumentation and Control for HVAC."

2.4 HEATING COILS

- A. Hot-Water: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
 - 1. Minimum two-row coils with tube thickness not less than 0.016".
 - 2. Coil performance shall be based on ARI 410.
- B. Where indicated, boxes shall be provided with a hot water heating coil and modulating control valve.
- C. Heating coils shall be removable without removing the terminal unit.

2.5 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Variable-volume damper assembly inside unit casing with control components located inside a protective metal shroud.
- B. Casing: 0.034-inch steel.
 - a. Casing Lining:
 - b. Thermal insulation equivalent in performance to 1-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with one of the following nonporous sheets:
 - 1) Foil.
 - 2) Tedlar.
 - c. Adhesive attached, 3/4-inch-thick, polyurethane foam insulation.
 - d. All linings and adhesives shall comply with the following standards:
 - 1) ASTM E 84 for Flame and Smoke, 25/50.
 - 2) ASTM C 665 for Fungi Resistance.
 - 3) UL 181 for Air Erosion and Mold Growth and Humidity.
 - 4) UL 723 for Flame and Smoke, 25/50.
- 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
- 3. Air Outlet: S-slip and drive connections.
- 4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
- C. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
 - 1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
 - 2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 6-inch wg inlet static pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units level and plumb.
- B. Maintain sufficient clearance for normal service and maintenance to all portions, including coil connections.
 - 1. Provide at least 24" clear in front of terminal unit control panel access.
 - 2. Provide at least NEC clearances in front of terminal unit disconnects.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air terminal units to allow service and maintenance.
- C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- D. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts".
- E. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Install 24VAC transformer for all terminal unit controls.
- I. Install discharge air temperature sensor at each terminal unit.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 - 3. Division 23 Section "Particulate Air Filtration" for HEPA media applied in HEPA filter grilles.

1.2 ACTION SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate drawing designation, model number, size, materials of construction, finish, and mounting details; and performance data including throw and drop, accessories, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Kreuger.
- B. MetalAire, Inc.; Metal Industries Inc.
- C. Nailor.
- D. Price Industries.
- E. Titus.

2.2 CAPACITIES AND CHARACTERISTICS

- A. Provide Grilles, Registers, and Diffusers with capacities and characteristics as indicated in the drawings.

- B. Maximum NC shall be 25 at CFM indicated, including neck damper.
- C. Coordinate frame style with drawings.
- D. Finish: Baked enamel, color selected by Architect.
- E. Ceiling mounted critical environment grilles, registers, and diffusers shall have an independent hanger or chain to structure.
- F. Insulate the top of the following supply air diffusers directly under an exposed roof.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Deliver and store clean and shrink wrapped. Touch up any paint damage.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Install insulation blankets on the back-pan of all air devices directly under an exposed roof. Refer to Division 23 "HVAC Insulation".
- E. At each ceiling and sidewall take-off from a duct, install an adjustable volume extractor with appropriate operator. Refer to Division 23 "Air Duct Accessories".

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

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SECTION 234000

HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.
- B. Related Sections include the following:
 - 1. Division 23 Section "Metal Ductwork" for duct materials and pressure classes.
- C. References and Standards
 - 1. AMCA 99 – Standards Handbook.
 - 2. ANST/UL-900 - Test Performance of Air Filter Units.
 - 3. ANSI/UL 586 - Test Performance of High Efficiency Particulate, Air Filter Units.
 - 4. ANSI/AWS D9.1-1990 – Specifications for Welding Sheet Metal.
 - 5. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - 6. "Biosafety in Microbiological and Biomedical Laboratories," by the U.S. Department of Health and Human Services. 4th Edition, Centers of Disease Control (CDC). DHHS Publication No. (CDC) 93-8395.
 - 7. DOE-STD-3020-97, SPECIFICATION FOR HEPA FILTERS USED BY DOE CONTRACTORS, January 1997
 - 8. IEST-RP-CC001.3 - HEPA and ULPA Filters -, The Institute of Environmental Science and Technology, Rolling Meadows, IL.
 - 9. IEST-RP-CC034.1 - HEPA and ULPA Filter Leak Tests - The Institute of Environmental Science and Technology, Rolling Meadows, IL.
 - 10. NIH Design Policy and Guidelines. Spring 2003.
 - 11. NSF/ANSI 49, Class II (laminar flow) biosafety cabinetry, NSF International Standard/American National Standard, 2004
 - 12. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.2 DEFINITIONS

- A. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate.
- B. HEPA: High-efficiency particulate air.
- C. ULPA: Ultra low penetration air.

1.3 ACTION SUBMITTALS

- A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test

method; fire classification; furnished specialties; frame construction and materials; and accessories for each model indicated.

- B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
 - 1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - 2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.
- B. Manufacturer's Letter:
 - 1. Manufacturer shall provide a letter of compliance along with cost proposal stating that the manufacturer complies with all requirements of specifications and drawings.
 - 2. For HEPA filter housing seals, manufacturer shall also provide written assurance that sealant is compatible with all decontamination materials including VHP.
- C. When specified performance characteristics are not published in the manufacturer's literature, the submittal data shall include certified documentation of performance by an approved independent test laboratory.
- D. For HEPA filter housings, all welding procedures, welders and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All production welds shall be visually inspected per standard procedure per ANSI/AWS D9.1-1990, "Specifications for Welding Sheet Metal" and shall be recorded with a certified weld inspection and report.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Comply with ARI 850.
- C. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.
- D. Comply with NFPA 90A and NFPA 90B.
- E. Manufacturer: All manufacturers shall specialize in the production of components specified herein for not less than three years documented experience and shall also issue a complete catalog with all data for the total product as described in "Submittals" above.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide one complete set of filters for each filter bank. If system includes prefilters, provide only prefilters.
 - 2. Provide one complete set of filters for each section of each unit to be installed when the project is turned over to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Configuration: Fabricate with fan(s), coils, etc. plus accessories, including:
 - 1. Filters.
 - 2. Filter Housings and Frames.
 - 3. Filter Gauges.
- B. Fabrication: Conform to AMCA 99 and ARI 430.
- C. All air filters shall be listed as Class 1 in accordance with Underwriters' Laboratories, Inc., Building Materials Director requirements, except ultrahigh efficiency filters (HEPA) shall be manufactured of materials that are so listed by UL.

2.2 FILTERS

- A. Type "A": Permanent Washable.
 - 1. Manufacturers:
 - a. AAF International
 - b. Camfil Type 44
 - c. Air-Maza P-5
 - 2. Description: Viscous coated, high velocity filters.
 - 3. Frame: Cardboard.
 - 4. Thickness: 2".
 - 5. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.10" w.g.
 - 6. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
 - 7. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.
- B. Type "B": Sectional, Renewable Media.
 - 1. Manufacturers:
 - a. American Air Filter RENU
 - b. Camfill D/C 22
 - 2. Description: Adhesive coated glass fiber media pads enclosed in sectional frames.

3. Frame: 16 gauge galvanized steel with mechanism for changing filter media.
4. Thickness: 2".
5. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.10" w.g.
6. Maximum Face Velocity: The net velocity shall not exceed 350 FPM.
7. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.

C. Type "C": Replaceable, Dry.

1. Manufacturers:
 - a. Camfill 30/30.
 - b. American Air Filter.
 - c. Air Guard.
 - d. Flanders.
2. Description: Pleated, disposable, nonwoven, lofted cotton media. The media shall be cemented to the inside of the frame to prevent air bypass.
3. Frame: Galvanized steel frame with 96% free support grid and contour stabilizers. The support grid and frame shall be continuously bonded to the leaving air face of the media.
4. Performance: MERV 8 (30%).
5. Thickness: 2".
6. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.30" w.g.
7. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
8. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.
9. Capacity: a 24" x 24" size shall be certified for a dust holding capacity of not less than 200 grams of ASHRAE Test Dust at 500 FPM and a final resistance of 1.0" w.g.

D. Type "D": Replaceable, Dry.

1. Manufacturers:
 - a. AmAir 1100.
 - b. Flanders 62RM11.
 - c. Camfill AP Eleven.
2. Description: High density, microfine glass fiber media laminated to a nonwoven synthetic backing. The media shall be cemented to the inside of the frame to prevent air bypass.
3. Frame: Galvanized beverage board frame with 96% free support grid and contour stabilizers. The support grid and frame shall be continuously bonded to the leaving air face of the media.
4. Performance: MERV 11 (65%).
5. Thickness: 4" – 12".
6. Initial Resistance: Initial clean resistance to air flow shall not exceed 0.35" w.g.
7. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
8. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.
9. Capacity: a 24" x 24" x 12" size shall be certified for the dust holding capacity above to a final resistance of 1.0" w.g.

E. Type "E": Replaceable, Dry.

1. Manufacturers:

- a. Camfill Aeropac or N/S Model III.
 - b. American Air Filter.
 - c. Flanders.
- 2. Description: High density, microfine glass fiber media laminated to a nonwoven synthetic backing. The media shall be cemented to the inside of the frame to prevent air bypass.
 - 3. Frame: Galvanized beverage board frame with 96% free support grid and contour stabilizers. The support grid and frame shall be continuously bonded to the leaving air face of the media.
 - 4. Performance: MERV 14 (90%).
 - 5. Thickness: 12".
 - 6. Initial Resistance: Initial clean resistance to air flow shall not exceed 1.0" w.g.
 - 7. Maximum Face Velocity: The net velocity shall not exceed 500 FPM.
 - 8. Installation: Filters shall be installed in side access or front access frames, as shown on the drawings. Filters in front access frames shall be furnished with lift handles.
 - 9. Capacity: a 24" x 24" x 12" size shall be certified for the dust holding capacity above to a final resistance of 1.75" w.g.

2.3 FILTER HOUSINGS AND FRAMES

A. Side Access Housings

- 1. All housings shall:
 - a. Be fabricated of not less than an all welded 16 gauge galvanized steel and be equipped with standing flanges and hinged access doors at both ends.
 - b. Receive filters of any manufacturer without alteration to filter, including 2" deep panel type prefilters, or housing.
 - c. Incorporate a permanent provision for sealing the filters against leakage around the entire perimeter of each filter, eliminating the need to purchase replacement filters with factory applied gasket strips. Replaceable woven pile seals shall be an integral component of the downstream flange of each extrusion so that the seals are compressed by the pressure drop across the filters, preventing bypass of unfiltered air.
 - d. Not exceed 36 inches in direction of air flow.
 - e. Be constructed and rated for use at listed air handling unit static pressures.
- 2. Doors are to be fitted with positive sealing, heavy duty multiple latches and with sponge neoprene gaskets.
- 3. Provide housings with static pressure taps.

B. Face Access Housings

- 1. All housings shall:
 - a. Be fabricated of not less than 16 gauge galvanized steel with holes prepunched for convenient assembly into banks.
 - b. Be a minimum of 2-5/8" deep for maximum structural strength and resistance to racking.
 - c. Be fitted with polyurethane foam gaskets, held in place by long lasting adhesive, and with a minimum of four heavy duty spring type fasteners.
- 2. Fasteners shall attach to the frames without requiring tools and shall be capable of withstanding 25 pounds of pressure without deflection.

3. All joints in the field assembled banks of frames shall be thoroughly caulked to prevent bypass of unfiltered air between frames and surrounding ductwork or plenum chambers.

2.4 FILTER GAUGES

- A. Manufacturers:
 1. Airguard Industries, Inc.
 2. Dwyer Instruments, Inc.
- B. Description: Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 1. Diameter: 4-1/2 inches.
 2. Range: The range of the scale shall start at 0 and end no greater than 1" w.g. (250 Pa) above the filter manufacturer's recommended final resistance for the type of filter to which the gauge is being applied.
- C. Accessories: Each gauge shall be provided with an adjustable signal flag, two static pressure tips with compression fittings, two three-way vent valves with compression fittings, two lengths of aluminum tubing, and a mounting plate with screws.
- D. For HEPA filter banks, the following shall also apply:
 1. Factory mounted photohelic gauge by Dwyer, 3003 SGT or engineer approved equal.
 2. Gauge shall have zero adjustment capability.
 3. In lieu of aluminum, provide stainless steel tubing, fittings, mounting brackets, identification labels.
 4. Identification labels shall be stitch welded to mounting bracket.
 5. Each gauge assembly shall be complete with stainless steel inline HEPA filters, tee fitting, gauge decontamination port, and 2-way stainless steel plug valves.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install filter frames according to manufacturer's written instructions.
- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- C. Install filters in position to prevent passage of unfiltered air.
- D. Install filter gauge for each filter bank.
- E. An integral transmitter shall read differential pressure across each filter bank and report to the FMS.
- F. Install filter gauge static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gauges on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gauges.

- G. Coordinate filter installations with duct and air-handling unit installations.
- H. Electrical wiring and connections are specified in Division 26 Sections.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components, filter and filter-frame installation, and electrical wiring, and to assist in field testing. Report results in writing.
- B. HEPA Filters:
 - 1. All HEPA filter housing requires that the filters can be quantitatively leak tested.
 - 2. The injection port and sampling ports shall be of sufficient size for insertion of the output line from the aerosol generator or photometer probe used by the owner or its authorized testing agency.
 - 3. Total leak test or efficiency test and scan leak tests shall be performed.
 - 4. The scan test apparatus must be qualified to be capable of traversing the entire filter sealing gasket and the perimeter of the filter support/duct housing structure in addition to the filter. Each test system is qualified only once prior to conducting periodic leak tests. The total leak test is prescribed in ASME N510-1989, Section 10, and the scan leak test is prescribed in IEST-RP-CC034.1.
 - 5. Access to Inject Challenge Aerosol: Access is required to permit the injection of challenge aerosol upstream of the filter. The aerosol can be injected at a device served by the filter system or via a port installed in the ductwork upstream of the features that accomplish the tasks listed in the following Sections.
 - 6. Mixing Devices Upstream of the Filter: The challenge aerosol should be mixed thoroughly using installed devices that are designed to induce turbulence, or by adding a device to create mixing by inducing turbulence, such as a Stairmand disk.
 - 7. Qualification to Ensure Uniform Downstream Concentration for Total Leak Test: Thorough mixing is required for any leaking aerosol downstream from the filter. Turbulence shall be induced using engineered system in the downstream airflow that produces mixing. An engineered turbulence induction and sampling manifold system which collects samples at multiple points downstream of all portions of the filter after mixing for concurrent measurement of the average concentration is allowed.
 - 8. Scan Test to Measure All Leaks:
 - a. Scanning one inch from the downstream ("clean") face of the filter is allowed provided that an engineered system shall be installed in the filter system at the time the system is built.
 - b. The scan test apparatus must be qualified by demonstrating it can measure leaks along the entire filter sealing gasket and the perimeter of the filter support/duct housing structure as well as leaks in the filter itself.
 - c. The scanning system shall consist of one or more funnel shaped collectors attached to an apparatus that can traverse over the duct section at one inch from the face of the HEPA filter in an overlapping fashion as prescribed in IEST-RPCC034.1. 6.0 Acceptance Criteria for In-Place Leakage Tests.

- d. The scan leak test measuring instrument shall be discrete particle measuring type with the ability to record and integrate individual leak test.
- e. Engineer and Owner shall review and approve any proposed alternative.

3.3 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 235100

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Listed double-wall vents.

B. Related Sections include the following:

1. Division 23 Section "HVAC Fans" for induced-draft and mechanical fans and for motorized and barometric dampers.
2. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Type B and BW vents.
2. Type L vents.
3. Special gas vents.
4. Building-heating-appliance chimneys.
5. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. American Metal Products; MASCO Corporation.
- 2. Ampco.
- 3. Hart & Cooley, Inc.
- 4. Metal-Fab, Inc.
- 5. Selkirk Inc.; Selkirk Metalbestos and Air Mate.

2.2 LISTED TYPE B AND BW VENTS

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.
- C. Inner Shell: ASTM B 209, Type 3105 aluminum.
- D. Outer Jacket: Aluminized steel.

2.3 LISTED TYPE L VENTS

- A. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F continuously, or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 2-inch airspace filled with high-temperature, ceramic-fiber or mineral-wool insulation.
- C. Inner Shell: ASTM A 666, Type 304 stainless steel.
- D. Outer Jacket: Stainless steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude 90 percent of rainfall.

2.4 LISTED SPECIAL GAS VENTS

- A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.
- C. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
- D. Outer Jacket: Stainless steel.

2.5 LISTED BUILDING-HEATING-APPLIANCE FLUES AND CHIMNEYS

- A. Description: Double-wall metal vents tested according to UL 103 and UL 959 and rated for 1400 deg F continuously, or 1800 deg F for 10 minutes; with positive or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.
- C. Inner Shell: ASTM A 666, Type 304 stainless steel.

2.6 ACCESSORIES

- A. General: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
- B. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.

2.7 GUYING AND BRACING MATERIALS

- A. Cable: Galvanized, stranded wires of the following thickness:
 - 1. Minimum Size: 1/4 inch in diameter.
 - 2. For ID Sizes 4 to 15 Inches: 5/16 inch.
 - 3. For ID Sizes 18 to 24 Inches: 3/8 inch.
 - 4. For ID Sizes 27 to 30 Inches: 7/16 inch.
 - 5. For ID Sizes 33 to 36 Inches: 1/2 inch.
 - 6. For ID Sizes 39 to 48 Inches: 9/16 inch.
 - 7. For ID Sizes 51 to 60 Inches: 5/8 inch.
- B. Pipe: Galvanized steel, NPS 1-1/4.
- C. Angle Iron: Galvanized steel, 2 by 2 by 0.25 inch.
- D. Delegated Design: Size and locate the guying and bracing system with the materials above in compliance with Division 23 "Vibration Isolation and Seismic Controls for HVAC" and with the approval of a registered structural engineer in good standing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed Type B and BW Vents: Vents for certified gas appliances.
- B. Listed Type L Vent: Vents for low-heat appliances.
- C. Listed Special Gas Vent: Condensing gas appliances.
- D. Listed Building-Heating-Appliance Flues and Chimneys:
 - 1. Engine generators: from muffler discharge to final point of exhaust termination
- E. Schedule 40 Steel Pipe:
 - 1. Engine generators
 - a. From muffler discharge to final point of exhaust termination.
 - b. From engine generator to muffler.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

- B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. For condensing appliances, lap joints in direction of condensate flow.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

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SECTION 235216
CONDENSING BOILERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.2 ACTION SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Short-circuit current rating of equipment assembly.

1.3 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.
- E. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Pulse-Combustion Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Prorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Cleaver Brooks.
 - 2. Fulton Boiler Works, Inc.
 - 3. Lochinvar Corporation.

2.2 MANUFACTURED UNITS

- A. Description: Factory-fabricated, -assembled, and -tested, condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- B. Heat Exchanger:
 - 1. Type 316L, stainless-steel primary and secondary combustion chamber.
 - 2. Finned-copper primary and stainless-steel secondary heat exchangers.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections.
- D. Burner: Natural gas, self-aspirating and self-venting after initial start.
- E. Blower: Centrifugal fan to operate during each burner firing sequence. Blower shall also prepurge and postpurge the combustion chamber as required by design.
 - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark or carbide hot surface source with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosure: NEMA 250, Type 1A.
 - 3. Finish: Baked-enamel or powder-coated protective finish.
 - 4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
 - 6. Mounting base to secure boiler to concrete base.
 - a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.
- I. Circulator Pump: Manufacturer provided circulation pump with cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Condensate Trap: Cast-iron body with stainless-steel internal parts.

2.3 TRIM

A. Hot Water

1. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
2. Aquastat Controllers: Operating, firing rate, and high limit.
3. Safety Relief Valve: ASME rated.
4. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
5. Boiler Air Vent: Automatic.
6. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
7. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant water temperature. Maintain set point plus or minus 2 percent.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
 - b. Include manufacturer's firing sequence for selection of multiple boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Facility Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

- a. Monitoring: On/off status, common trouble alarm.

- b. Control: On/off operation, hot water supply temperature set-point adjustment.
- 2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 for indoor enclosures.
 - 2. Wiring shall be numbered and color-coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in a metal raceway.
 - 4. Field power interface shall be to fused disconnect switch.
 - 5. Provide branch power circuit to each motor and to controls with a circuit breaker.
 - 6. Provide each motor with overcurrent protection.
- C. Ratings
 - 1. Short-Circuit Current: Match rating of overcurrent protective device serving motor controllers.
 - 2. Available Short-Circuit Current: As indicated on the Drawings.

2.6 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install boilers level on 6" tall concrete base. Concrete materials and installation requirements are specified in Division 03.
- B. Vibration Isolation: Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Install electrical devices furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.

- H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- I. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: Provide on-site assistance in adjusting system to suit actual occupied conditions for 12 months of Substantial Completion.
- E. Performance Tests:
 - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 - 3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
 - 4. Repeat tests until results comply with requirements indicated.
 - 5. Provide analysis equipment required to determine performance.

6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 235700

HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes shell-and-tube and plate heat exchangers.
- B. Related sections include the following:
 - 1. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
 - 2. Division 23 Section "HVAC Insulation".
 - 3. Division 23 Section "Hydronic Piping".
 - 4. Division 23 Section "Instrumentation and Controls for HVAC".
 - 5. Division 23 Section "Steam and Condensate Heating Piping".

1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
 - 2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Tube-removal space.
 - 2. Structural members to which heat exchangers will be attached.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."
- B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Alfa Laval Thermal, Inc.
- B. Armstrong Pumps, Inc.
- C. ITT Industries; Bell & Gossett.
- D. Mueller, Paul Company.
- E. Taco, Inc.

2.2 GASKETED PLATE HEAT EXCHANGERS

- A. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Provide heat exchanger rated for domestic water service and compliant with NSF 61.
- B. Frame:
 - 1. Capacity to accommodate 50 percent additional plates.
 - 2. Painted carbon steel with provisions for anchoring to support.
 - 3. Frame shall allow up to 15% thermal expansion with no loss of performance.
- C. End-Plate Material: Painted carbon steel.
- D. Tie Rods and Nuts: Steel or stainless steel.
- E. Plate Material: 0.024 inch thick before stamping; Type 304 stainless steel.
- F. Gasket Material: Nitrile rubber or EPDM.
- G. Piping Connections:
 - 1. End plate with welded carbon-steel nozzles. Threaded pipe connection for NPS 2 and smaller; carbon-steel flanged pipe connection for larger sizes.
- H. Enclose plates in a solid aluminum or stainless-steel removable shroud.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HEAT-EXCHANGER INSTALLATION

- A. Install shell-and-tube heat exchangers on saddle supports.
- B. Install plate-and-frame heat exchangers on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.
- C. Install shutoff valves at heat-exchanger inlet and outlet connections.
- D. Install relief valves on heat-exchanger heated-fluid connection and install pipe from relief valves, full size of valve connection, to floor drain.
- E. Install vacuum breaker at heat-exchanger steam inlet connection.
- F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 237313

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes constant and variable volume, modular air-handling units with coils for indoor installations.
- B. Related Sections include the following:
 - 1. Division 23 Section "Hydronic Pumps" for in pan condensate pumps.
 - 2. Division 23 Section "Hydronic Piping" for accessories and piping requirements at hydronic coils integral to units.
 - 3. Division 23 Section, "Instrumentation and Control for HVAC" for type, arrangement, and sequences for modular AHUs.
 - 4. Division 23 Section "HVAC Air Filtration" for filter performances.
 - 5. Division 23 Section "Steam and Condensate Piping" for accessories and piping requirements at steam coils to units.
 - 6. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for seismic and wind restraint requirements.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified coil-performance ratings with system operating conditions indicated.
 - 4. Motor ratings, electrical characteristics, and motor and fan accessories.
 - 5. Material gages and finishes.
 - 6. Filters with performance characteristics.
 - 7. Dampers, including housings, linkages, and operators.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Short-circuit current rating of equipment assembly.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each unit to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- F. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- G. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of structural-steel support members.

1.7 WARRANTY

- 1. In conjunction with and supporting Factory warranty OEM shall furnish complete factory authorized service and maintenance of equipment for 1 year from Date of Substantial Completion by factory trained technicians.
- 2. OEM shall provide quarterly, annual, and bi-annual maintenance in compliance with or exceeding ASHRAE Standard 180-2008.

3. Complete Warranty: Provide one a five year warranty to include both parts and labor. Warranty shall cover the entire unit and factory accessories, including the following:

1. Coils
2. Dampers and damper actuators
3. Fans
4. Motors
5. Motor starters
6. VFDs
7. Control panel and components

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: A minimum of one set for each modular indoor air-handling unit.
2. Fan Belts: One set for each modular indoor air-handling unit fan.
3. Gaskets: Two sets for each access door size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Climate Craft.
- B. JCI / YORK, a Johnson Controls company. Basis of Design.
- C. Temtrol.

2.2 MANUFACTURED UNITS

- A. Modular indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, mixing dampers, control devices, and other accessories, sections, or components as shown in the Contract Documents.
- B. Provide protection for all openings and components during equipment transport. Externally mounted components shall be protected during all phases of transport from exposure, including moisture and ambient temperatures outside of any component's operating range. Externally mounted components include, but are not limited to, VFD's, actuators, sensors, and weather hoods.

2.3 CABINET

- A. Unit leakage not to exceed 1% of design CFM at 8" maximum w.g. operation. Leakage to be calculated by totaling all leakage either into or out of the unit.
- B. Materials: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

1. Outside Casing: Galvanized steel, 0.0635 inch thick.
 2. Inside Casing: Galvanized steel, 0.0276 inch thick.
 3. Floor Plate: Galvanized steel, 0.1382 inch thick.
- C. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.
 2. Thermal performance: units shall have a minimum effective insulating value of R-12.
 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
 4. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
 5. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 6. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.
 7. Location and Application: Encased between outside and inside casing.
- D. Access Panels and Doors: Same materials and finishes as cabinet, complete with hinges, latches, handles, and gaskets. Inspection and access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access panels and doors in the following locations:
1. Fan Section: Inspection and access doors.
 2. Access Section: Doors.
 3. Coil Section: Inspection panel.
 4. Damper Section: Inspection and access doors.
 5. Filter Section: Inspection and access doors to allow periodic removal and installation of filters.
- E. Condensate Drain Pans: Formed sections of stainless-steel sheet complying with requirements in ASHRAE 62 for all cooling coils. Fabricate pans with slopes in two planes to collect condensate from coils (including coil piping connections and return bends) and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 2. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil. Drain intermediate pan to main pan via copper downspout.
- F. Condensate Pump: Fractional horsepower, non-ferrous impeller, close or direct coupled pump for installation in drain pan complete with floats or sensors to detect water level and cycle pump accordingly. Each drain pan shall have a minimum of one pump, unless otherwise indicated.
- G. Unit Paint
1. External surfaces of unit casings shall be prepared and painted resulting in a minimum 1.5 mil thick coating when dry.
 2. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours.
 3. Paint shall be AHU Manufacturer's standard color, unless otherwise indicated.

4. For units requiring a color other than the AHU Manufacturer's standard color, the Architect shall provide a quantity of four 2" x 2" paint samples to the AHU Manufacturer at the time of submittal approval.

2.4 FAN SECTION

- A. Fan-Section Construction: Belt or direct-drive fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan with vibration isolation.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housings with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.
 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Performance Class: AMCA 99-2408, Class II or III.
 3. Horizontal Flanged Split Housing: Bolted construction.
 4. Plug Fans: With steel cabinet. Fabricate without fan scroll and volute housing.
- C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.
- D. Backward-Inclined Fan Wheels: Steel construction with curved inlet flange, backplate, and backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. Forward-Curved Fan Wheels: Black-enamel or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- F. Airfoil-Fan Wheels: Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- G. Coatings: Hot-dip galvanized.
- H. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- I. Bearings:
 1. Bearing Types:
 - a. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.

- b. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - c. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
- 2. Bearing Rating Life:
 - a. Ball-Bearings: ABMA 9, L10 at 200,000.
 - b. Roller-Bearings: ABMA 11, L10 at 200,000.
- J. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.5.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys:
 - a. For motors through 10 hp, use adjustable pitch. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - b. For motors larger than 10 hp and for all motors with a VFD, use fixed pitch.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
- K. Vibration Control: Install fans on open-spring vibration isolators having a minimum of 1-inch static deflection and side snubbers.
- L. Fan-Section Source Quality Control:
 - 1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 - 2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
 - 3. Fans integral to units shall not exceed 85% of class rating at the selection point.
- M. Fan Arrays: For fan sections where 2 or more fans serve a single air stream or unit section, each individual fan shall comply with all parts of this section and the following.
 - 1. Each fan shall be independently driven.
 - 2. All fans shall be factory wired to a single enclosure.
 - 3. For VAV services, the factory supplied enclosure shall:
 - a. Include two VFD's, each sized for 50% of the array for controlling and monitoring fan speed.
 - b. Fans shall either modulate speed, or stage individual fans on/off to achieve balanced airflow through the fan array and meet scheduled performance.
 - c. Provide contacts in a common terminal strip to monitor all fans. Fan status shall be indicated by an LED in the controls enclosure. A common alarm shall signal the FMS when any fan fails.

4. In the event of the failure of any single fan the remaining fans shall be able to supply to design CFM and ESP as scheduled.
5. Provide motorized or manual damper to isolate each individual fan from array upon fan or motor failure. Isolation damper shall prevent bypass air through the fan array.

2.5 MOTORS

- A. General: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Noise Rating: Quiet.
- C. Provide grounding ring on motor shaft.
- D. Provide VFDs for all fan motors.

2.6 COILS

- A. Coil Sections: Common or individual, insulated. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
- B. Hydronic Coils: Cleanable coil fabricated according to ARI 410.
 1. Piping Connections: Threaded, on same end.
 2. Tubes: Copper.
 3. Fins: Aluminum with fin spacing as scheduled.
 - a. Minimum spacing: 8 fins per inch.
 - b. Maximum spacing: 12 fins per inch.
 - c. Maximum fin length of 120".
 - d. Provide intermediate tube supports for coils over 44" long, with an additional support every multiple of 42" thereafter.
 4. Fin and Tube Joint: Mechanical bond.
 5. Headers: Seamless copper tube with brazed joints, prime coated.
 6. Frames: Minimum thickness 0.0625 inch.
 - a. Heating Coils: Galvanized-steel channel.
 - b. Cooling Coils: Stainless steel channel.
 7. Drain pans: Provide
 8. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
 - a. Working-Pressure Ratings: 200 psig, 325 deg F.
 9. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2.7 DAMPERS

- A. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Damper Operators: Electric and complying with Division 23 Section "Instrumentation and Control for HVAC."
- C. Low-Leakage, Outside-Air Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed or parallel-blade arrangement as indicated in the Contract Documents with steel operating rods rotating in a stainless-steel sleeve or sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

2.8 FILTER SECTION

- A. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or the face.
- B. Filtration: Provide as scheduled. Refer to Division 23, "HVAC Air Filtration," for filtration system performance.
- C. Quality Assurance: Comply with NFPA 90A or 90B as required.

2.9 ELECTRICAL

- A. The electrical connections for all electrical components in each unit shall be wired by the AHU manufacturer to the exterior of the unit for field connection.
- B. Provide disconnect at each motor internal to the unit.
- C. Marine Lights
 - 1. Marine lights shall be provided throughout AHUs, but no less than one per section with an access door.
 - 2. Lights shall be compact fluorescent type to minimize amperage draw and shall produce lumens equivalent to a minimum 64 W, instant-start bulb.
 - 3. Lights shall be constructed of safety glass and shall be suitable for wet locations.
- D. Marine Light Switches
 - 1. All lights on a unit shall be wired in the factory to a single on-off switch with an integral timer adjustable for up to forty five minutes.
 - 2. Lighting circuit(s) shall be wired by the AHU Manufacturer to a common junction box separate from the VFD or starter so the lights can remain on when the main disconnect to the unit is on or off.
- E. Convenience Outlet
 - 1. Manufacturer shall provide at least one duplex 120-V convenience outlet per fan section.

2. Outlets shall be wired by AHU Manufacturer to a common junction box separate from VFD or starter so the outlet can remain on when the main disconnect to the unit is on or off.

F. Ratings

1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
2. Available Short-Circuit Current: As indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Concrete Bases: Install floor mounting units on 6-inch-high concrete bases. See Division 23 Section "Common Work Results for HVAC" for concrete base materials and fabrication requirements.
- B. Install modular indoor air-handling units with the following vibration and seismic-control devices. Vibration and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 1. Units with Internally Isolated Fans: Set units on 1/2" neoprene pads, 40 durometer, on concrete bases. Secure units to anchor bolts concrete bases.
 2. Floor-Mounted Units without Internally Isolated Fans: Support on concrete bases using housed-spring isolators. Secure units to anchor bolts installed in concrete bases.
 3. Suspended Units: Suspend units from structural-steel support frame using threaded steel rods and spring hangers.
- C. Arrange installation of units to provide access space around modular indoor air-handling units for service and maintenance.
- D. Install temperature sensor on the leaving side of all cooling and heating coils in AHUs.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.

- C. Connect VFDs to associated fan motors. Comply with Division 23 and 26 for installation requirements.
- D. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- E. Install condensate pump in drain pan and route condensate discharge to indirect waste.
 - 1. Install condensate trap of adequate depth to seal against the pressure of fan section. Install cleanouts in piping at changes of direction.
 - 2. Install condensate piping at appropriate slope to gravity drain.
- F. Connect condensate drain pans using minimum NPS 1-1/4, Type M copper tubing. Extend to nearest equipment or floor drain. Install condensate trap of adequate depth to seal against the pressure of fan section and connect to drain pan. Install cleanouts at changes in direction of condensate piping.
- G. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. For units without internally isolated fans, make final duct connections with flexible connections. Internally isolated fan units do not require flexible connections.
- H. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- K. Connect all control points indicated in the Contract Documents to the FMS.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Leak Test: After installation, fill water and steam coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
 - 2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

- B. Final Checks before Startup: Perform the following:
1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Set outside- and return-air mixing dampers to minimum outside-air setting.
 7. Comb coil fins for parallel orientation.
 8. Install clean filters.
 9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- C. Starting procedures for modular indoor air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.
 4. Adjust damper linkages for proper damper operation.
- D. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for modular indoor air-handling system testing, adjusting, and balancing.

3.6 CLEANING

- A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units. Refer to Division 01 Section "Demonstration and Training."

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SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Related Sections include the following:
 - 1. Division 23 Section "Hydronic Piping" for condensate piping.
 - 2. Division 23 Section "Instrumentation and Control for HVAC" for controls components.
 - 3. Division 23 Section "Common Motor Requirements for HVAC" for all motors.
 - 4. Division 23 Section "Vibration Isolation" for seismic criteria and restraint performance.

1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Short-circuit current rating of equipment assembly.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- B. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
- E. Units shall be designed to operate with HCFC-free refrigerants.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.
 - 2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Air Conditioning; Div. of Carrier Corporation.
- B. Daikin.
- C. Lennox Industries Inc.
- D. Trane Company (The).
- E. York International Corp.

2.2 CONCEALED EVAPORATOR-FAN COMPONENTS

- A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 1. Insulation: Foil faced, glass-fiber duct liner.
 - 2. Drain Pans: Stainless steel, with connection for drain; insulated.
- B. Coils:
 - 1. Refrigerant: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
 - 2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.
 - 3. Electric: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- C. Fan: Forward-curved, double-width wheel of galvanized steel; belt or directly connected to motor.
- D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- E. Filtration: Provide as scheduled. Refer to Division 23, "HVAC Air Filtration," for filtration system performance.
- F. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- G. Electrical Ratings
 - 1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
 - 2. Available Short-Circuit Current: As indicated on the Drawings.

2.3 FLOOR-MOUNTING, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
 - 1. Discharge Grille: Steel with surface-mounted frame or welded steel bars forming a linear grille and welded into supporting panel.
 - 2. Insulation: Foil faced, glass-fiber, duct liner.
 - 3. Drain Pans: Stainless steel, with connection for drain; insulated.
- B. Coils:
 - 1. Refrigerant: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.
 3. Electric: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- C. Fan: Belt or direct drive, centrifugal.
- D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- E. Filtration: Provide as scheduled. Refer to Division 23, "HVAC Air Filtration," for filtration system performance.
- F. Electrical Ratings
1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
 2. Available Short-Circuit Current: As indicated on the Drawings.

2.4 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
- B. Coils:
1. Refrigerant: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
 2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a two-position control valve.
 3. Electric: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- C. Fan: Belt or direct drive, centrifugal fan.
- D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- E. Filtration: Provide as scheduled. Refer to Division 23, "HVAC Air Filtration," for filtration system performance.
- F. Electrical Ratings

1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
2. Available Short-Circuit Current: As indicated on the Drawings.

2.5 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Steel, with baked enamel finish, with removable panels for access to controls and coils, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 1. Compressor Type: Reciprocating or scroll.
 2. Variable speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 3. Refrigerant Charge: R-407C or R-410A.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Aluminum-propeller type, directly connected to motor.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Low Ambient Kit: Permits operation down to 0 deg F (-18 deg C).
- H. Mounting Base: Polyethylene.
- I. Electrical Ratings
 1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
 2. Available Short-Circuit Current: As indicated on the Drawings.

2.6 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Provide in-pan condensate pump complete with piping, floats, controls, FMS alarm contacts, etc.
 1. Condensate piping to be ASTM B 306, Type DWV copper with wrought copper fittings conforming to ASME B16.22 and soldered.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install roof-mounting compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install seismic restraints per site requirements as defined by Architect and/or Structural Engineer.
- F. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- G. Install in-pan condensate pump and route discharge to nearest code approved location. Discharge to drain shall be open sight and with an air gap.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Water Coil Connections: Comply with requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
 - 2. Condensate Pump Connections: Comply with requirements in Division 23 Section "Hydronic Piping." Comply with disconnect requirements for power in Division 26.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

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SECTION 238219

FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes fan-coil units and accessories.
- B. Related Sections include the following:
 - 1. Division 23 Section "General-Duty Valves for HVAC Piping" for valves and accessories for piping.
 - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion fittings.
 - 3. Division 23 Section "HVAC Insulation" for pipe saddles at pipe hangers.
 - 4. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
 - 5. Division 23 Section "Hydronic Piping" for chilled water, heating water, and condensate piping.
 - 6. Division 23 Section "Instrumentation and Control for HVAC".
 - 7. Division 23 Section "Metal Ducts".
 - 8. Division 23 Section "Packaged Compressor and Condenser Units" for split systems.

1.2 DEFINITIONS

- A. FMS: Facility management system.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Short-circuit current rating of equipment assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension components.
 - 2. Structural members to which fan-coil units will be attached.
 - 3. Method of attaching hangers to building structure.

4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
6. Perimeter moldings for exposed or partially exposed cabinets.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
- B. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves or roof openings for outdoor-air intake.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
 - 2. Fan Belts: Furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Corporation.
- B. Daikin.
- C. Engineered Air Ltd.
- D. Environmental Technologies, Inc.
- E. Trane.
- F. YORK International Corporation.

2.2 FAN-COIL UNITS

- A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- B. Coil Section Insulation: 1-inch thick, foil-covered, closed-cell foam or matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
 - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- C. Main and Auxiliary Drain Pans: Insulated stainless steel or insulated galvanized steel with plastic liner formed to slope from all directions to the drain connection as required by ASHRAE 62. Drain pans shall be removable.
- D. Condensate Pump: Fractional horsepower, non-ferrous impeller, close or direct coupled pump for installation in drain pan complete with floats or sensors to detect water level and cycle pump accordingly. Each drain pan shall have a minimum of one pump, unless otherwise indicated.
 - 1. Condensate piping to be ASTM B 306, Type DWV copper with wrought copper fittings conforming to ASME B16.22 and soldered.
- E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.
- F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint, unless otherwise indicated by Architect.

1. For non-ducted and exposed units:
 - a. Vertical Unit Front Panels: Removable, steel, with steel or cast-aluminum discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
 - b. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with steel or cast-aluminum discharge grilles.
 - c. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard colors. Return grille shall provide maintenance access to fan-coil unit.
 - d. Steel recessing flanges for recessing fan-coil units into ceiling or wall.
 2. For ducted and partially exposed units:
 - a. Vertical Unit Front Panels: Removable, steel, with steel or cast-aluminum discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
 - b. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with steel or cast-aluminum discharge grilles.
 - c. Steel recessing flanges for recessing fan-coil units into ceiling or wall.
 - d. Insulated sheet metal plenums with flex connections where the following services connect to the unit:
 - 1) Supply air.
 - 2) Return air.
 - 3) Outside air.
 - 4) Relief air.
 - 5) Bypass air.
- G. Filtration: Provide as scheduled. Refer to Division 23, "HVAC Air Filtration," for filtration system performance.
- H. Coils:
1. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- I. Fan and Motor Board: Removable.
1. Fan:
 - a. Belt-Driven: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 - b. Direct-Driven: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 3. Wiring Termination: Connect motor to chassis wiring with plug connection.

- J. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F, with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 - 2. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 - 3. Wrought-Copper Unions: ASME B16.22.
 - 4. Risers: ASTM B 88, Type L copper pipe with hose and ball valve for system flushing.
- K. Control devices are specified in Division 23 Sections "Instrumentation and Control for HVAC".
- L. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- M. Electrical Ratings
 - 1. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
 - 2. Available Short-Circuit Current: As indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend horizontal, suspended fan-coil units from structure with hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Verify installation locations of thermostats and other exposed control sensors with Architect.
- E. Do not operate fan coil units without filters installed.
- F. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

- G. Maintain maintenance and all NEC clearances.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
 - 3. Install condensate pump in drain pan and route condensate discharge to indirect waste.
 - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
 - b. Install condensate piping at appropriate slope to gravity drain.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

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SECTION 238239

UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 DEFINITIONS

- A. FMS: Facility management system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Details of anchorages and attachments to structure and to supported equipment. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 4. Location and arrangement of piping valves and specialties.
 - 5. Location and arrangement of integral controls.
 - 6. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which unit heaters will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 6. Perimeter moldings for exposed or partially exposed cabinets.
 7. Final mullion height for baseboard installation.
- B. Samples for Initial Selection: Finish colors for units with factory-applied color finishes for Architect's approval.
- C. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Airtherm; a Mestek Company.

- B. Carrier Corporation.
- C. Chromalox, Inc.
- D. Dunham-Bush, Inc.
- E. Indeeco.
- F. Markel Products.
- G. Marley Engineered Products divisions: Berko Electric Heating, Marley Electric Heating, QMark Electric Heating.
- H. Trane.

2.2 WALL AND CEILING HEATERS

- A. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Casing:
 - 1. Front Panel: Stamped-steel louver or extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
 - 2. Finish: Baked enamel over baked-on primer with manufacturer's color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.
- D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.
- E. Fan: Aluminum propeller directly connected to motor.
 - 1. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- F. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
- G. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.3 BASEBOARD HEATERS

- A. Description: An assembly including chassis, electric heating coil, and controls. Comply with UL 2021.
- B. Casing:

1. Description: Floor mounted unit completely enclosed with front intake near floor and top discharge even with adjacent mullion.
 2. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
 3. Finish: Clear anodized.
- C. Coils
1. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.
 2. Hydronic: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- D. Controls: Control set point to be enabled / disabled and temperature reset from DDC system to local remote thermostat and relayed to each group of baseboard heaters on a common facing or zone. Provide transformer relay to control electric heat coils in series through a common signal. Provide low-voltage relay with transformer kit.
- E. Electrical Connection: Factory wire controls for minimum field connections with disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinet unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Coordinate baseboard unit floor support heights with architectural mullion. Architect to provide break metal accessories so that baseboard heater appears integral to floor mullion.
- D. Suspend unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

- E. For units with filter sections, install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
- E. Comply with safety requirements in UL 1995.
- F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
- G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 238413

HUMIDIFIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following humidifiers:
 - 1. Self-contained.
- B. Related Sections include the following:
 - 1. Division 23 Section "HVAC Insulation".

1.2 DEFINITION

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, including the piping of safety relief valves, plans, elevations, sections, details of components, manifolds, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Short-circuit current rating of equipment assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which humidifiers will be attached.
 - 2. Size and location of initial access modules for acoustical tile.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.8 COORDINATION

- A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Armstrong International, Inc.
- B. DRI-STEEM Humidifier Company.
- C. Nortec Industries Inc.
- D. Pure Humidifier Company.
- E. Spirax Sarco.

2.2 SELF-CONTAINED HUMIDIFIERS

- A. Electric Source
 - 1. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 316 stainless steel. Comply with UL 499.
 - 2. Electrode Cylinder: Replaceable plastic assembly. Comply with UL 499.
 - 3. Electrical Ratings
 - a. Short-Circuit Current: Match rating of overcurrent protective device serving the equipment assembly.
 - b. Available Short-Circuit Current: As indicated on the Drawings.
- B. Manifold: ASTM A 666, Type 316 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends.

- C. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.
- D. Control Panel:
 - 1. Factory-wired disconnect switch.
 - 2. Electronic display.
 - 3. Programmable keyboard.
 - 4. Set-point adjustment.
 - 5. Warning signal indicating end of replaceable cylinder life.
 - 6. Low-voltage, control circuit.
 - 7. Diagnostic, maintenance, alarm, and status features.
 - 8. High-water sensor or float to prevent overfilling.
- E. Controls:
 - 1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
 - 2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
 - 3. Field-adjustable timer to control drain cycle for flush duration and interval.
 - 4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
 - 5. Conductivity or Float-type level controls.
- F. Accessories:
 - 1. Humidistat: Wall or Return-duct-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control as indicated in drawings.
 - 2. Duct-mounting, high-limit humidistat.
 - 3. Airflow switch for preventing humidifier operation without airflow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance.
- B. Seal humidifier manifold duct or plenum penetrations with flange.
- C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

- D. Install stainless-steel drain pan under each manifold mounted in duct.
 - 1. Construct drain pans to comply with ASHRAE 62.
 - 2. Connect to condensate trap and drainage piping.
 - 3. Extend drain pan upstream and downstream from manifold a minimum of 24 inches or as recommended by manufacturer.
 - 4. Install condensate pump in drain pan to discharge cooled effluent to indirect waste.
- E. Install manifold supply piping pitched to drain condensate back to humidifier.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to humidifiers to allow service and maintenance.
 - 2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
 - 3. Install a drain cooler to reduce the temperature of all effluent discharged to the sanitary system below 140°F.
- B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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Volume 3 of 3



**MIDWESTERN STATE UNIVERSITY
HEALTH SCIENCE & HUMAN SERVICES CENTER
WICHITA FALLS, TEXAS**

RSA Project #1612.00

100% CONSTRUCTION DOCUMENTS

September 1, 2017

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264113	Lightning Protection for Structures	Sept. 1, 2017	
264300	Surge Protective Devices	Sept. 1, 2017	
265100	Interior Lighting	Sept. 1, 2017	
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DIVISION 27 - COMMUNICATIONS			
270000	Communications	Sept. 1, 2017	
270526	Grounding and Bonding for Communications Systems	Sept. 1, 2017	
270528	Pathways for Communications Systems	Sept. 1, 2017	
270810	Optical Fiber Testing and Measurement	Sept. 1, 2017	
271100	Communications Room Fittings	Sept. 1, 2017	
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271500	Horizontal Cabling	Sept. 1, 2017	
274113	Architecturally Integrated Audio Visual Infrastructure	Sept. 1, 2017	
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DIVISION 28 - ELECTRONIC SAFETY AND SECURITY			
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282300	Video Surveillance	Sept. 1, 2017	
282600	Emergency Intercom and Duress	Sept. 1, 2017	
283100	Fire Detection and Alarm	Sept. 1, 2017	
283500	Refrigerant Detection and Duress	Sept. 1, 2017	
DIVISION 31 - EARTHWORK			
311000	Site Preparation	Sept. 1, 2017	
312000	Earth Moving	Sept. 1, 2017	
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312334	Excavation and Backfill for Conduits	Sept. 1, 2017	
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316329	Drilled Piers	Sept. 1, 2017	
DIVISION 32 - EXTERIOR IMPROVEMENTS			
320130	Landscape - Maintenance of Site Improvements - Two Years	Sept. 1, 2017	
321313	Portland Cement Concrete Paving	Sept. 1, 2017	
321314	Concrete Paving - Architectural Finishes	Sept. 1, 2017	
321413	Precast Concrete Unit Paving	Sept. 1, 2017	

SECTION NUMBER	SECTION NAME	ORIGINAL ISSUE DATE	LATEST REV. DATE
321600	Concrete Curbs and Gutters	Sept. 1, 2017	
321723	Pavement Markings.....	Sept. 1, 2017	
328400	Landscape Irrigations System	Sept. 1, 2017	
329200	Turf and Grasses.....	Sept. 1, 2017	
329300	Landscaping - Organic	Sept. 1, 2017	
DIVISION 33 - UTILITIES			
331100	Water Conduit Installation	Sept. 1, 2017	
333100	Sanitary Sewer Line Installation	Sept. 1, 2017	
334100	Storm Sewer Line Installation.....	Sept. 1, 2017	
334114	Landscape Drainage with Bridging Stone	Sept. 1, 2017	

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SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. The requirements contained in this Section apply to all Sections of this Division.
- B. Section Includes:
 - 1. Common terminology and requirements used throughout this Division.
 - 2. Requirements for Acceptance Testing Agency.
 - 3. Requirements for Professional Engineers responsible for Delegated Design.
 - 4. Electrical equipment coordination and installation.
 - 5. Sleeves for raceways and cables.
 - 6. Sleeve seals.
 - 7. Grout.
 - 8. Common electrical installation requirements.

1.2 DEFINITIONS

- A. AHJ: Authorities Having Jurisdiction.
- B. ANSI GRAY: Where this Section and other Sections of this Division use the term "ANSI GRAY" it shall mean the manufacturer's standard ANSI Gray.
- C. Bound Material: Bound refers to materials permanently bound, as by stitching or glue, or materials securely fastened in their covers by multiple fasteners that penetrate all papers. Ring binders, spiral binders, brads and screw posts are acceptable fasteners. Loose papers clipped together or stapled at one corner are not acceptable.
- D. Business Day: Where this Section and other Sections of this Division use the term "Business Day" it shall mean Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.
- E. EPDM: Ethylene-propylene-diene terpolymer rubber.
- F. FMS: Facility management system.
- G. NETA ATS: Acceptance Testing Specification, as published by InterNational Electrical Testing Association.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. NIST: National Institute of Science and Technology.
- J. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- K. RS-485: A TIA standard for multipoint communications using two twisted-pairs.

- L. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.3 PERFORMANCE REQUIREMENTS

- A. The Drawings diagrammatically show the sizes and locations of various equipment and devices, and the sizes of the major interconnecting wires, without showing exact details as to elevations, offsets, control wiring and other installation requirements. Carefully layout the Work at the site to conform to the architectural and structural conditions, to avoid obstructions and to permit proper grading of pipe associated with other portions of the Work. In cooperation with other trades, determine the exact location of equipment and devices and connections thereto by reference to the submittals and rough-in drawings, and by measurements at the site. Make minor relocations necessitated by the conditions at the site, or directed by the Owner, without additional cost to the Owner.

1.4 SUBMITTAL PROCEDURES

- A. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
 - 1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.
 - 2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files shall be in Portable Document Format (.pdf).
 - 3. Product Data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.
- B. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
 - 1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®.
 - 2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 - 3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
 - 4. Shop Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
- C. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project Management and Coordination". In addition to the requirements of Division 01 comply with the following:
 - 1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.

2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
 4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
- D. Common Requirements for Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" for "Other Informational Submittals". In addition to the requirements of Division 01 comply with the following:
1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with "Compliance". Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
 - a. "C" for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
 - b. "D" for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
 - c. "A" for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
 - d. "N/A" for Not Applicable: By noting the term "not applicable" or "N/A" in the margin, it shall be understood that the specified item is not applicable to the project.
- E. Common Requirements For Qualification Data:
1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of registration in the Project location.
 2. Independent Testing and Inspecting Agency Certification: Where this Section and other Sections of this Division require an Independent Testing and Inspecting agency to be responsible for Acceptance Testing and Field Quality Control requirements; Submit certification documentation for such agency that demonstrates compliance with the Quality Assurance paragraph of this Section.

1.5 ACTION SUBMITTALS

- A. Product Data: Submit product data for each of the following.
1. Sleeves.
 2. Sleeve seals.
 3. Grout.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Prepare drawings showing dimensioned layout for the following:

1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.
2. Reflected Ceiling Plans: ceiling plans, sections, and other necessary details showing dimensioned layouts for equipment located in or on the ceiling plane. Base dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the following items coordinated with each other, based on input from installers of the items involved:
 - a. Suspended ceiling components.
 - b. Structural members to which suspension systems for luminaires will be attached.
 - c. Perimeter moldings, decorative ceiling elements, and Architectural features.
 - d. Luminaires.
 - e. HVAC Diffusers, Registers and Grilles.
 - f. Speakers.
 - g. Sprinklers.
 - h. Fire Alarm initiating devices, including but not limited to the following:
 - 1) Smoke detectors.
 - 2) Heat detectors.
 - 3) Flame detectors.
 - i. Fire Alarm notification appliances.
 - j. Occupancy sensors.
 - k. Access panels.
 - l. Security cameras and occupancy detectors.
 - m. Wireless Access Points.
 - n. Location of structural supports for seismic bracing.
3. Electrical Equipment Layouts: Floor plans, elevations, and other necessary details showing dimensioned layouts for spaces containing electrical equipment. Base electrical equipment dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the following items coordinated with each other, based on input from installers of the items involved:
 - a. Electrical equipment layout and relationships between components and adjacent structural and mechanical elements.
 - b. Indication of required working clearances and required area above and around electrical equipment where pipes and ducts are prohibited.
 - c. Location of Conduit entry into electrical equipment.
 - d. Location of luminaires, sprinkler piping and heads, ducts, and diffusers.
 - e. Electrical equipment support locations, type of support, and weight on each support.
 - f. Location of structural supports for structure-supported raceways.
 - g. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.
 - h. Location of structural supports for seismic bracing.

1.7 QUALITY ASSURANCE

- A. Common Requirements for Independent Testing and Inspecting Agency Qualifications: Where this Section and other Sections of this Division call for an Independent Testing and Inspecting Agency (Testing Agency); the Testing Agency shall comply with the following requirements:
 1. Have the experience and capability to conduct the testing indicated,

2. Be a member company of the InterNational Electrical Testing Association (NETA) or a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction and the Engineer-of-Record.
 3. Meet the Requirements of NETA ATS 3.0 including, but not limited to, the following:
 - a. Be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated.
 - b. Be regularly engaged in the testing of seismic support of electrical equipment devices, installations, and systems.
 - c. Use technicians who are regularly employed for testing services.
 - d. Have a "Full Membership" classification issued by the InterNational Electrical Testing Association meets the above criteria.
 4. Testing Agency's Field Personnel: Technicians performing specified electrical tests and inspections shall meet the Requirements of NETA ATS 3.0 including, but not limited to, the following:
 - a. Technicians performing specified electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
 - b. Technicians shall be certified in accordance with ANSI/NETA ETT-2000, Standard for Certification of Electrical Testing Personnel. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.
- B. Common Requirements for Material Quality: Materials, equipment and devices shall be new and of the quality specified, and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment or devices identical with those damaged, unless approved otherwise by the Owner in writing.
- C. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern. Perform the following:
1. Promptly notify the Architect in writing of any such difference.
 2. Obtain approval from Architect before proceeding with the Work.
 3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.
- D. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:
1. Promptly notify the Architect in writing of any such difference.
 2. Obtain approval from Architect before proceeding with the Work.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
1. Wherever a UL standard has been established for a particular type of material, equipment or device, each item of such material, equipment or device provided shall meet the requirements of the UL standard.

1.8 PRODUCT SUBSTITUTIONS

- A. Comply with provisions of Division 01 Section "Product Requirements".
 - 1. If item of equipment or device offered as Substitution differs in dimension or configuration from that indicated in the Contract Documents, provide, as part of the substitution submittal, a drawing that shows that the equipment or devices proposed for Substitution can be installed in the space available without interfering with other trades or with access requirements for operations and maintenance in the completed project. Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
 - 2. Where substitute equipment or devices requires different arrangement or connections from that indicated in the Contract Documents, install the equipment or devices to operate properly and in accordance with the requirements of the Contract Documents. Make incidental changes necessary in piping, ductwork or wiring which results from the inclusion of the substitute equipment or device without any additional cost to the Owner. Pay all additional costs incurred by other trades in connection with changes required by the inclusion of the substituted equipment or device in the Work.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and Owner no fewer than five business days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Schedule of Work in Existing Facilities:
 - 1. The building will continue in use throughout the construction period, carry out the Work in such a manner as to minimize disturbance to the occupants.
 - 2. The schedule contemplates working in designated areas in the existing building while other adjacent areas are still being occupied. Carry out the Work in such a manner as to minimize disturbance to those occupied areas.
 - 3. Should the Work in the designated areas affect any services to the areas that are to remain in use, new permanent or temporary services or a combination of both shall be installed as required to enable those occupied areas to function properly and without interruption.
 - 4. Perform no work in the existing building which would interfere with its use during normal hours of occupancy, including but not limited to operations which would cause objectionable noise or service interruptions, unless special permission is granted by the Owner.
- C. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving large equipment into place. Where any piece of equipment is too large for ingress through normal building openings it shall be placed in its containing space before the enclosing structure is completed.
- D. Temporary Power: Where temporary power is required during the construction period, comply with ANSI/NECA 200 "Recommend Practice for Installing and Maintaining Temporary Power at Construction Sites."

1.10 COORDINATION

- A. In describing various materials, equipment and devices, in general each item may be described singularly, even though there may be a multiplicity of identical items. Also, where the description is general in nature, the exact sizes, duties, space arrangements, horsepower and other requirements must be obtained by reference to other portions of Contract Documents.
- B. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer. Verify that all materials, equipment and devices proposed for use on this Project are within the constraints of the allocated space.
- C. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping, ductwork and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- D. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- E. Utility Service Coordination:
 - 1. Electrical Service: Coordinate the location of the electrical service entrance with the electric utility company and with other trades. Provide materials and equipment required to connect the electrical service.
- F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- G. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- H. For roof-mounted equipment: Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.

- b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The Drawings do not indicate existing installations other than to identify modifications or extensions thereto. Visit the site and ascertain the existing conditions. Review construction details of the existing portion of the building during the site inspection. Include all work required to remove or modify portions of the existing installation in order to accommodate the new Work. Failure to comply with this will not be considered grounds for additional payment in connection with removing or modifying any part of the existing installation or installing any new or temporary work.

3.2 TEMPORARY WORKING ACCESS

- A. Remove existing wire, conduit, equipment, fixtures, and other items as required to provide access for Work in existing facilities.
- B. Reinstall and refinish items removed, or otherwise damaged, to match existing adjacent conditions upon completion of the Work.

3.3 SALVAGE, DEMOLITION AND RELOCATION

- A. Modify, remove, salvage, or relocate materials, equipment and devices as indicated or required by the installation of new Work.

- B. Salvage and Demolition: Working jointly with the Owner's Representative, establish and mark salvage and demolition items before commencing work; report items scheduled for relocation, reinstallation or reuse, which are found to be in damaged condition; await further instructions from the Owner before commencing Work.
1. Demolition material shall be removed from the site and disposed of in a legal manner.
 2. Salvaged equipment and devices shall be the property of the Owner, unless otherwise indicated. Store salvaged items in locations as directed by Owner.
 3. For devices and equipment marked for demolition, remove all conduit and wiring back to the point of origination, unless otherwise indicated.
 4. Where existing walls are demolished, remove all existing electrical devices, their associated conduit and wiring back to the point of origination.
 5. Where entire circuits are removed, turn the circuit breaker off and label as "spare".
 6. Maintain service to all "existing to remain" devices and equipment that may be interrupted during demolition.
 7. Upon completion of demolition, ensure that remaining devices that may have been interrupted during demolition are energized.
- C. Relocations: Make minor relocations necessitated by the conditions at the site or as directed by the Owner's Representative, without additional cost to the Owner.
1. Remove items which are to be relocated in reverse order to original assembly or placement.
 2. Protect items until relocation is complete.
 3. Clean, Repair and restore to good functional condition, equipment, materials and items scheduled for relocation. Provide new fittings and appurtenances required to complete the relocations and to restore to good operating order.
- D. Substitution of New materials for Relocation: New materials of similar design and quality may be substituted for materials and items indicated to be relocated upon approval of Owner and Architect. Comply with Division 01 for Substitution Procedures.

3.4 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. All materials, equipment and devices shall be installed in accordance with the recommendations of their manufacturer.
- B. Comply with NECA 1 - Standard Practices for Good Workmanship in Electrical Construction, as published by the National Electrical Contractors Association.
- C. Use licensed technicians skilled in their respective trades for installation of the Work.
- D. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless otherwise indicated.
- E. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a manner as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- G. Right of Way: Give to piping systems installed at a required slope.

- H. Access Panels: Provide wall and ceiling access panels for unrestricted access to all concealed electrical equipment items and devices installed behind furrings, chases or non-removable suspended ceilings. Access Panel materials and installation requirements are specified in Division 08 Section "Access Doors and Frames."
- I. Installation Inspections and Certifications
 - 1. Obtain timely inspections of the installation by Authorities Having Jurisdiction. Remedy any deficiencies to the satisfaction of the inspecting official.
 - 2. Upon final completion of the Work, obtain certificates of acceptance from the Authorities Having Jurisdiction. Deliver the certificates to the Owner.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves where cable or conduit penetrations occur. Install sleeves during erection of slabs and walls.
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Exception: Slab-on-grade construction shall not require sleeves or curbed formed openings when conduits or pipes that penetrate the slab-on-grade are installed and properly supported prior to the pouring of the slab.
- C. Masonry Walls: Install sleeves where cable or conduit penetrations occur. Install sleeves during erection of walls.
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- F. Non Fire-Rated Assemblies: Install sleeves where cable penetrations occur. Install sleeves during erection of walls.
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors a minimum of 2 inches above finished floor level.
- I. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless otherwise indicated or **unless seismic criteria requires different clearance**.
- J. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
 - 2. Apply approved joint compound for gypsum board assemblies where masonry or concrete wall is faced on interior side with gypsum board.

- K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- M. Roof-Penetration Sleeves: Seal penetration of individual conduits and cables with flashing units applied in coordination with roofing work. Provide flashing unit as specified in Division 07 Section "Sheet Metal Flashing and Trim".
- N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.6 OPTION TO RELOCATE DEVICES

- A. The location of power, wall switches and other similar devices along with their associated connections may be relocated at the Owner's option, at no additional cost to the Owner, to a point within 10 feet of their present location provided the Contractor is notified prior to rough-in or installation.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 UTILITIES

- A. The location and voltage of electrical lines included within the Work are indicated in the Contract Documents in accordance with information furnished by the Owner. Existing utility lines not indicated in Contract Documents but encountered during construction shall be protected, relocated or capped as directed by the Owner.
- B. Prior to excavation, examine the site and verify the location and elevation of all utilities and their relation to the Work. Identify and label all underground utilities occurring within the bounds of the area to be excavated. Contact the known utilities and engage a certified locator service to assist in this effort.
- C. Prior to excavation, contact the known utilities and inform them of excavation work plan. Proceed with excavation only after receiving approval from Utilities.
- D. Assist the Owner in arranging for the removal of existing utility lines within the scope of this Project that are labeled to be abandoned or removed with the respective Utility.

- E. All precautions shall be exercised to prevent damage to existing lines, but should work become necessary, it must be authorized prior to execution except in an emergency situation.
- F. Should damage result to any utility through the Contractor's negligence or failure to comply with the above directives, the Contractor shall bear the sole responsibility to correct such damage and shall be responsible for all expenses incurred in the expeditious repair or replacement of such damaged Utilities.
- G. Repair of damaged utilities shall be to a condition equal to or better than the adjacent undamaged portion of such utility and to the complete satisfaction of the Owner and respective Utility.

3.9 CONNECTIONS

- A. Phase Rotation: Prior to installing any connections or energizing any equipment, perform Phase Rotation verification test at the following:
 - 1. Utility Transformers
 - 2. Engine Generators
 - 3. Motors
 - 4. Connections to existing electrical equipment.
- B. Mechanical Controls: Provide 120VAC power connections as required to components of Mechanical Control system. Coordinated quantity of circuits, connection requirements and locations between trades and with provisions of Divisions 21, 22, and 23 sections.
- C. HVAC Terminal Boxes: Where the Drawings indicate a 120VAC circuit in a general area and labeled for terminal boxes (VAV, etc.), the intent is for this circuit to be extended and connected to the terminal box in that general area. Coordinate connection requirements and locations between trades and with provisions of Division 23 Sections and Drawings.
- D. Smoke Dampers: Where the Drawings indicate a 120VAC circuit in a general area and labeled for dampers, the intent is for this circuit to be extended and connected to the Smoke and Fire/Smoke dampers in that general area in coordination with the smoke control sequence. Coordinated connection requirements and locations between trades and with provisions of Division 23 Sections and Drawings.
- E. Security and Access Control: Where the Drawings indicate a 120VAC circuit in a general area labeled for security or access control use, the intent is for this circuit to be extended and connected to the security or access control device in that general area in coordination with other trades. Coordinated connection requirements and locations between trades and with Owner's Security vendor prior to installation.
- F. Motors and Motor Connections: Motors for driven equipment are specified in Divisions 21, 22, and 23. Provide connections as follows, unless otherwise indicated:
 - 1. Equipment provided with factory installed disconnecting means: Upon installation of motor and associated equipment, Provide the electrical installation in accordance with approved wiring diagrams and manufacturer's written instructions.
 - 2. Equipment furnished with factory disconnecting means: Upon installation of motor and associated equipment, Install factory furnished disconnecting means and provide the electrical installation in accordance with approved wiring diagrams and manufacturer's written instructions.
 - 3. Equipment not furnished with factory installed disconnecting means: Provide disconnect switch required in accordance with NFPA 70 or as indicated on the

Drawings. Provide the electrical installation in accordance with approved wiring diagrams and manufacturer's written instructions.

- G. Owner Furnished Equipment: Power Connections and Control wiring required for Owner Furnished Equipment may not be shown on the Drawings. This wiring shall be provided. Coordinated connection requirements and locations with Owner.
 - 1. Request all rough-in documentation required for proper installation of the electrical work in ample time to permit preparation of the installation drawings.

3.10 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
- B. Apply putty pads to boxes located in fire-rated wall assemblies in which a horizontal distance of greater than 24" between boxes is not maintained. Putty pad materials and installation requirements are specified in Division 09 Section "Gypsum Board Assemblies."

3.11 SEALANT

- A. Apply sealant to penetrations of all floor and wall assemblies to maintain pressure differentials required by AIA for all pressure sensitive rooms. Sealant materials and installation requirements are specified in Division 07 Section "Joint Sealants" and Division 09 Section "Gypsum Board Assemblies."

3.12 FIELD QUALITY CONTROL

- A. Conduct tests as part of the Work of this Division. Include the services of qualified personnel as well as all equipment, apparatus, and services required.
- B. Conduct tests under conditions free from short circuits and from grounds.
- C. Insure insulation resistance prior to test is within the requirements of the latest edition of the NFPA 70.
- D. Prior to execution of testing, notify Architect of proposed test procedures and forms.
- E. Testing requirements are listed under individual sections of this Division. Sections requiring testing include, but are not limited to the following:
 - 1. Wire and cable insulation, in accordance with Division 26 Sections Medium-Voltage Cables" and "Low-Voltage Electrical Power Conductions and Cables."
 - 2. Grounding system continuity, in accordance with Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 3. Monitoring operational and system continuity, in accordance with Division 26 Section "Electrical Power Monitoring and Control."
 - 4. Lighting controls and system diagnostic, in accordance with Division 26 Section "Network Lighting Controls."
 - 5. NETA tests for transformers, in accordance with Division 26 Section "Low-Voltage Transformers."
 - 6. NETA tests and startup for switchboards, in accordance with Division 26 Section "Switchboards."
 - 7. NETA tests and startup for panelboards, in accordance with Division 26 Section "Panelboards."

8. NETA tests and startup for enclosed controllers, in accordance with Division 26 Section "Enclosed Controllers."
9. NFPA 110 acceptance tests and startup for generators, in accordance with Division 26 Section "Engine Generators."
10. Tests and startup uninterruptible power systems, in accordance with Division 26 Section "Static Uninterruptible Power Supply."
11. Tests and startup for transfer switches, in accordance with Division 26 Section "Transfer Switches."
12. NETA tests for surge protection devices, in accordance with Division 26 Section "SPD for Low-Voltage Electrical Power Circuits."
13. NETA thermographic survey on all electrical system equipment.

END OF SECTION

SECTION 260513

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes cables and related splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.
- B. Related Sections include the following:
 - 1. Division 26 Section "Low-Voltage Electrical Power Conductors And Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems 600 V and less.

1.2 DEFINITIONS

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.
- C. Sheath: A continuous metallic covering for conductors or cables.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each type of product indicated. Provide data for conductors and cables including, but not be limited to, the following:
 - 1. Complete physical properties of the conductors and cables.
 - 2. Ampacity for use intended.
 - 3. Allowable stresses and requirements for installations, including bend radii, linear stress, and other pertinent data.
 - 4. Splicing and termination kit materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical". Include the following:
 - 1. Cable routing plans, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - a. Cable lengths use in fault calculations.
 - b. Proposed cable pull points.
 - c. Structural members in the paths of conduit groups with common supports.
 - d. HVAC and plumbing items and architectural features in the paths of conduit groups. Denote where systems share common supports.
 - e. Proposed splice locations.

- B. Product Certificates: For each type of splicing and termination kit, signed by product manufacturer.
 - C. Qualification Data: For Installer; Include manufacturer's certificate of training listing the following:
 - 1. Installer's name.
 - 2. Date and duration of last training class attended.
 - 3. Years of work experience slicing medium voltage cables.
 - D. Material Certificates: For each cable and accessory type, signed by manufacturers.
 - E. Source quality-control test reports.
 - F. Field quality-control test reports.
- 1.5 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For medium-voltage cables, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for cables, terminations and all installed components.
- 1.6 QUALITY ASSURANCE
- A. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
 - B. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
 - 1. Installer experience in slicing medium voltage cables: minimum of five years.
 - C. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- 1.7 PROJECT CONDITIONS
- A. Interruption of Existing Electric Service: Comply with requirements defined in Division 26 Section "Common Work Results for Electrical".

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cables:
 - a. Aetna Insulated Wire, Inc.; a Berkshire Hathaway company.
 - b. General Cable Technologies Corporation.
 - c. Kerite; a Marmon Wire & Cable/Berkshire Hathaway company.
 - d. Okonite Company (The).
 - e. Prysmian Cables & Systems.
 - f. Southwire Company.
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. Adalet; a Scott Fetzer company.

- b. DSG-Canusa; a Shawcor company.
- c. Engineered Products Company.
- d. G&W Electric Company.
- e. MP Husky.
- f. RTE Components; Cooper Power Systems, Inc.
- g. Thomas & Betts Corporation.
- h. Thomas & Betts Corporation/Elastimold.
- i. 3M; Electrical Markets Division.
- j. Tyco Electronics; Raychem Products.

2.2 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with IEEE C2 and NFPA 70.

2.3 CABLES

- A. Cable Type: MV105; Ethylene-propylene rubber Insulation.
- B. Comply with UL 1072 and AEIC CS 8.
- C. Comply with ICEA S-93-639, and ICEA S-97-682
- D. Conductor: Copper
- E. Conductor Stranding: Compact round, concentric lay, Class B.
- F. Strand Filling: Conductor interstices are filled with impermeable compound.
 - 1. Voltage Rating: 15 kV.
 - 2. Insulation Thickness: 133 percent insulation level.
- G. Shielding: Uncoated copper tape shield helically applied over semiconducting insulation shield with minimum 12.5% overlap
- H. Cable Jacket:
 - 1. Sunlight-resistant PVC
 - 2. No Lead Sunlight-resistant PVC
 - 3. Chlorosulfonated polyethylene, CPE.

2.4 SPLICE KITS

- A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
- B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
 - 1. Combination tape and cold-shrink-rubber sleeve kit with re-jacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
 - 2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
 - 3. Premolded, cold-shrink-rubber, in-line splicing kit.

4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.5 SOLID TERMINATIONS

- A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations. Provide mastic seal at the ground strap and lug end of termination. Grease seals and hand taped terminations are not acceptable.
 1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
 2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
 3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
 4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

2.6 SEPARABLE INSULATED CONNECTORS

- A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
- B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
- C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.
- E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
 1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
 2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
 3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
 4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

- F. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.
- G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.7 ARC-PROOFING MATERIALS

- A. Tape for First Course on Metal Objects: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.
- C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Engage a factory-authorized service representative to conduct an on-site course for proper installation methods and application of splices and terminations.

3.2 INSTALLATION

- A. Install cables according to IEEE 576.
- B. Comply with NECA/NEMA 600 "Standard for Installing and Maintaining Medium-Voltage Cable" as published by the National Electrical Contractors Association.
- C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 1. Before cable is pulled into conduit, thoroughly swab the conduit to remove all foreign material and to permit the cable to be pulled into a clean, dry conduit.
 - 2. Form each cable carefully in cabinets, equipment, pull boxes, and manholes.
 - 3. Make bends in cables larger than the minimum radii required by the NFPA 70 and in the cable manufacturer's published data.
 - 4. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
 - 5. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
 - 6. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
 - 7. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- H. Cable Splices:
 - 1. Route cable to minimize cable splices.
 - 2. Obtain engineers approval of cable route and splice locations prior to installation.
- I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits. Maintain seal during construction to avoid entrance of moisture
- J. Terminations at Medium Voltage Switchgear:
 - 1. Properly torque bolted connections prior to the application of termination protection materials.
 - 2. Protect all terminations to insulated bus or bushing connections.
- K. Install separable insulated-connector components as follows:
 - 1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
 - 2. Portable Feed-Through Accessory: Three.
 - 3. Standoff Insulator: Three.
- L. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable where cables from different circuits are located within shared manholes or switchgear compartments where cables are not protected by conduit, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 - 5. Band arc-proofing tape with 1-inch-wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.
- M. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."
- N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.
- O. Identify cables according to Division 26 Section "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - 2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
- B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.
- C. Correct Deficiencies, Retest and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a written report, certified by testing agency, to record the following:
 - a. Procedures used.
 - b. Results that comply with requirements, identifying conductor, units, and devices checked.
 - c. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
 - d. Observations and test results after remedial action.

END OF SECTION

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SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 26 Section "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. VFC: Variable frequency controller.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each type of product indicated. Provide data for conductors and cables including, but not be limited to, the following:
 - 1. Complete physical properties of the conductors and cables.
 - 2. Ampacity for use intended.
 - 3. Allowable stresses and requirements for installations, including bend radii, linear stress, and other pertinent data.
 - 4. Types of connectors for terminations.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical". Include the following:
 - 1. Cable lengths for use in fault calculations.
 - 2. Feeder cable routing plans, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - a. Structural members in the paths of conduit groups with common supports.
 - b. HVAC, plumbing items, and architectural features in the paths of conduit groups. Denote where systems share common supports.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For conductors and cables, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:

1. Manufacturer's routine maintenance requirements for cables, terminations and all installed components.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

B. Aluminum and Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. XHHW Conductors: Comply with NEMA WC 70.

D. Aluminum Conductors: XHHW-2

1. Comply with NEMA WC 70.
2. AA-8000 series electrical grade aluminum alloy conductor material in compliance with NFPA 70, Chapter 3.
3. Compact stranded conductors.

E. Shielded Variable Frequency Drive Cable: Shielded Conductor and signal cable with symmetric bare grounds and overall shield to block EMI and RFI interference.

1. Conductor Material: stranded tinned copper
2. Shield: Foil tape and tinned copper braid shield
3. Comply with 2000V UL 1277 Type TC-ER per 2005 NEC Article 336
4. Rated for 90°C wet/dry
5. Suitable for Class I & II; Division 2 hazardous locations
6. Comply with UL 1685 vertical tray flame test

7. Comply with IEEE 1202 vertical tray flame test at 70,000 BTU/hour
 8. Comply with CSA FT4
 9. Comply with Oil & Sunlight resistant
 10. RoHS compliant and CE approved.
- F. Conductor Insulation: Comply with NEMA WC 70/IECA S-95-658 for Types THHN-THWN, XHHW, XHHW-2 and SO, as indicated.
- G. Multiconductor Cables: Comply with NEMA WC 70/IECA S-95-658; Exterior sheath color coded to differentiate cable voltages and quantity of phase conductors.
1. Health Care Facilities armored cable, Type AC-HCF; Comply with UL 4 and UL 1479; with green grounding conductor(s) in addition to Armor/Bond Wire ground combination; with exterior sheath colored green.
 2. Health Care Facilities Metal-clad cable, Type MC^{AP}-HCF; Comply with UL 1569 and UL 1063; with green grounding conductor(s) in addition to full size aluminum ground wire/sheath combination that is listed for sheath to act as second ground path; with exterior sheath colored green.
 3. Armored cable, Type AC; comply with UL 4 and UL 1479. with green grounding conductor(s) in addition to Armor/Bond Wire ground combination. Listed for use in Environmental Air space according to NPFA 70 Article 300.
 4. Metal-clad cable, Type MC; comply with UL 1569 and UL 1479; with green grounding conductor(s). Listed for use in Environmental Air space according to NPFA 70 Article 300.
 5. Mineral-insulated, metal-sheathed cable, Type MI; with green grounding conductor(s). Listed for use in Environmental Air space according to NPFA 70 Article 300.
 6. Nonmetallic-sheathed cable, Type NM; with green grounding conductor(s).
 7. Type SO; with green grounding conductor(s).

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
 2. Gardner Bender.
 3. Hubbell Power Systems, Inc.
 4. Ideal Industries, Inc.
 5. IlSCO; a branch of Barden Corporation.
 6. NSI Industries LLC.
 7. O-Z/Gedney; a brand of the EGS Electrical Group.
 8. 3M; Electrical Markets Division.
 9. Tyco Electronics.
 10. WAGO Corporation.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 MISCELLANEOUS PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength: 50 lb, minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black, except where used for color-coding. Refer to Division 26 Section "Identification for Electrical Systems" for color-coding requirements.

2.4 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for all feeders, aluminum for feeders where indicated on Drawings. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Stranded for wire.
- B. Branch Circuits: Copper. Solid or stranded for No. 10 AWG and smaller; stranded for No. 8 AWG and large.
- C. Provide conductors with minimum temperature ratings of 75 degrees C. For high temperature applications, provide conductors with temperature ratings in accordance with the NFPA 70 for the ambient condition.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance:
 1. Copper: Type THHN-THWN, single conductors in raceway.
 2. Aluminum: Type XHHW-2, single conductors in raceway, where indicated on Drawings.
- B. Exposed Feeders:
 1. Copper: Type THHN-THWN, single conductors in raceway.
 2. Aluminum: Type XHHW-2, single conductors in raceway, where indicated on Drawings.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace:
 1. Copper: Type THHN-THWN, single conductors in raceway.
 2. Aluminum: Type XHHW-2, single conductors in raceway, where indicated on Drawings.
- D. Feeders below Slabs-on-Grade, and Underground:
 1. Copper: Type THHN-THWN, single conductors in raceway.
 2. Aluminum: Type XHHW-2, single conductors in raceway, where indicated on Drawings.
- E. Feeders Installed below Raised Flooring:
 1. Copper: Type THHN-THWN, single conductors in raceway
 2. Aluminum: Type XHHW-2, single conductors in raceway, where indicated on Drawings.

- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway and Type AC in limited locations where indicated Type AC-HCF and Type MCAP-HCF in limited locations where indicated Type MC in limited locations where indicated.
 - 1. Type AC Type AC-HCF and Type MC^{AP}-HCF and Type MC is are acceptable for the following applications.
 - a. Install cables for lighting fixture whips and for branch circuits concealed in walls and partitions only.
 - 1) Do not install the cable in the vertical web of metal studs.
 - 2) Route cable horizontally using pre-fabricated openings in web of metal stud.
 - 3) Use only single-circuit cable (i.e. two wire plus ground). For devices in the same wall connected to different circuits, install separate single circuit cable for each circuit.
 - 4) Locate junction box and convert to single conductors in rigid raceway within 24-inches from the point the cable exits the wall.
 - 5) Locate junction box and convert to single conductors in rigid raceway within the same room as where the cable enters/exits the wall.
 - a) For branch power circuits limit length of AC-HCF and MC^{AP}-HCF to 30' from the junction box to the wiring device located in the wall. If the circuit continues outside the wall, the circuit must immediately transition to conduit.
 - b) For branch lighting circuits limit length of AC-HCF and MC^{AP}-HCF to 30' from the junction box to the first fixture and from that point only those fixtures above the enclosed space/room shall be served by the HCF circuit.
 - 2. Type AC Type AC-HCF and Type MC^{AP}-HCF and Type MC is are not acceptable for the following applications; instead provide single conductors in rigid raceway.
 - a. Homeruns to Panelboard.
 - b. Branch circuits serving Essential Electrical System (Emergency & Standby) loads; including Life Safety branch, Critical branch and equipment emergency system.
 - c. Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
 - d. Within mechanical, electrical or telecommunication equipment rooms.
 - e. Exposed Branch Circuits within areas that do not have a ceiling (i.e. open to structure).
 - f. Wet Locations.
- H. Branch Circuits below Slabs-on-Grade, and Underground in limited locations where indicated: Type THHN-THWN, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.
- J. Connections to Luminaires on Normal System: Type THHN-THWN, single conductors in raceway as specified in Division 26 Section Raceways and Boxes for Electrical Systems Armored Cable, Type AC-HCF, maximum of 144 inches (3660 mm) Armored Cable, Type AC, maximum of 144 inches (3660 mm).
- K. Connections to Luminaires on Essential/Emergency System: Type THHN-THWN, single conductors in raceway as specified in Division 26 Section Raceways and Boxes for

Electrical Systems Armored Cable, Type AC-HCF, maximum of 144 inches (3660 mm)
Armored Cable, Type AC, maximum of 144 inches (3660 mm).

- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- M. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- N. Class 2 and 3 Control Circuits; Concealed in Ceilings, Walls or Partitions: Power-limited cable or Type THHN-THWN, in raceway.
- O. Class 2 and 3 Control Circuits; Exposed: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Run feeders in continuous lengths, without joints or splices. Where continuous runs are impractical; obtain Engineer's approval for splice locations and application.
- B. Make joints in branch circuits only where circuits divide.
- C. Do not use gutters of panelboards as raceways, junction boxes, or pull boxes for conductors not terminating in said panelboards.
- D. Run conduits for emergency power conductors separate from all other wiring.
- E. Make splices and terminations in cables with kits and instructions provided by the kit manufacturer. Each splice shall equal the integrity of the cable electrically and environmentally.
- F. Bundling Conductors: Bundle conductors in switchboards, panelboards, cabinets, and the like, using nylon ties made for the purpose. Bundle conductors larger than No. 10 in individual circuits. Smaller conductors may be bundled in larger groups.
- G. Install all conductors in raceways, unless otherwise indicated.
- H. Sizes:
 - 1. Provide conductors no smaller than No. 12 AWG, except for signal or control circuits.
 - 2. Provide No. 10 AWG conductors for home runs on 120-volt, 20-ampere branch circuits, where the conductor length exceeds 100 lineal feet from panelboard to the first device.
 - 3. Provide No. 10 AWG conductors for home runs on 277-volt, 20-ampere branch circuits, where the conductor length exceeds 200 lineal feet from panelboard to the first device.
 - 4. Provide neutral conductors of the same size as the phase conductor(s) for individual branch circuit homeruns.
 - 5. Run dedicated neutral conductor with each branch circuit. Sharing of neutral conductors in multi-circuit homeruns is not acceptable.
 - a. Sharing of neutrals would necessitate the use of multiple-pole or tied branch circuit breakers to allow simultaneous disconnecting of current carrying conductors in order to comply with NFPA 70 requirements and therefore is unacceptable.
 - 6. Grouping of Multi-Circuit homeruns: grouping of multiple circuits into shared conduit homeruns is acceptable where they comply with the quantities and sizes listed in Table "A" below and where homeruns meet the following conditions:

- a. Where conductors are THWN/THHN installed in dry location.
- b. Where raceways are installed in ambient conditions less than 30-Deg C (86-Deg F).
- c. Consider neutral conductors as a current carrying conductor in branch circuits which serve receptacles or electronic ballasted luminaries.

TABLE A

Number of Current Carrying Conductors in single raceway	Conductor Size for 20Ampere Single Pole Circuit	Conduit Size based on EMT
2 to 3	#12 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	3/4" EMT
4 to 6	#12 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	3/4" EMT
7 to 9	#10 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	1" EMT 3/4" EMT
10 to 20	#10 AWG (THHN 90-Deg)	1.25" EMT

Notes:

1. Conductor and conduit sizes in table above are based on total conductor lengths under 100 lineal feet for 120-volt (200 lineal feet for 277-volt) from panelboard to the first device, 20-ampere branch circuits. Increase conductor and conduit size in accordance with NFPA 70 for longer lengths.

- I. Terminations of multiple branch circuit conductors on a single circuit breaker is not acceptable.
 - J. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
 - K. Complete raceway installation between conductor and cable termination points according to Division 16 26 Section "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
 - L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours.
 - M. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
 - N. Feeders and Branch circuits concealed in concrete are prohibited.
- 3.4 WIRE PULLING
- A. Pull no conductors into conduits until all Work of a nature which may cause injury to conductors is completed.
 - B. Follow manufacturers' recommendations for regulating temperature conditions of conductors prior to installation.
 - C. Exercise care in handling and installing cables to avoid damage. Carefully form cables in equipment pull boxes. Form bends in cables larger than the minimum radii shown in the cable manufacturer's published data for minimum bends such that bends will not reduce the cable life.

- D. Provide suitable installation equipment to prevent abrasion and cutting of conductors by raceways during the pulling of conductors. Use ropes of polyethylene, nylon or other suitable non-metallic material to pull in feeders. Metallic ropes are prohibited.
- E. Attach pulling lines to conductors by means of insulated woven basket grips or by pulling eyes attached directly to conductors. Do not use rope hitches, or bare steel basket grips. All conductors to be installed in a single conduit shall be pulled in simultaneously.
- F. Before any wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.
- G. Use manufacturer-approved pulling compound or lubricant where necessary, of non-conducting type. Compounds used must not deteriorate the conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- H. Do not use cable pulling lubricants on conductors of ungrounded circuits which are electrically monitored by ground detector system, since such lubricant may increase the capacities to ground of these conductors.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor.
- C. Wiring at Outlets: Install conductor at each device, with at least 6 inches (150 mm) of slack.
- D. Wiring at lighting control locations: Install a neutral conductor at each switch location controlling line-to-neutral lighting loads.
- E. Connectors: Make splices and connections in conductors using approved connectors.
 - 1. Provide lugs and connectors of proper size to match conductor size.
 - 2. Stranded Conductors: Solder-less, bolted pressure or compression connectors.
 - 3. Solid Conductors: Bolted pressure or spring connectors.
 - 4. Motor Lead Pigtails: Crimp lugs with through-bolt fasteners between lugs. Furnish proper sized dies and tools to apply connectors.
 - 5. Lighting Fixture Taps: Electrical spring connectors as specified for solid conductors.
 - 6. Ground Connections: Ground connection materials and installation requirements are specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Provide temperature ratings of connectors and splices to match wire rating.
- G. Connections for Aluminum Conductors using Mechanical Screw Type Connectors:
 - 1. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
 - 2. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
 - 3. Clean the conductor surface using a wire brush and apply a Listed joint compound.

4. Tighten the connection per the connector manufacturer's recommendation.
 5. Wipe off any excess joint compound.
- H. Connections for Aluminum Conductors using Mechanical Compression Type Connectors:
1. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
 2. The lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color coded. Lug barrel shall be factory prefilled with a joint compound Listed by UL.
 3. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
 4. Clean the conductor surface using a wire brush.
 5. Crimp the connection per the connector manufacturer's recommendation.
 6. Wipe off any excess joint compound.
- I. Termination of Aluminum Conductor to Aluminum Bus:
1. Prepare a mechanical connection conforming to F or G above.
 2. Hardware:
 - a. Bolts: Anodized aluminum alloy 2024-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
 - b. Nuts: Aluminum alloys 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.
 - c. Washers: Flat aluminum alloy 2024-T4, Type "A" plain, standard wide series conforming to ANSI B27.2.
 - d. Lubricate and tighten the hardware as per the manufacturer's recommendations.
- J. Termination of Aluminum Conductor to Copper Bus:
1. Prepare a mechanical connection conforming to F or G above.
 2. Hardware:
 - a. Bolts: Plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to ASTM A-325 or SAE grade 5.
 - b. Nuts: Heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B.
 - c. Washers: Steel; Type A plain standard wide series conforming to ANSI B27.2.
 - d. Belleville conical spring washers: hardened steel, cadmium plated or silicone bronze.
 - e. Lubricate and tighten the hardware as per the manufacturer's recommendations.
- K. Termination of Aluminum Conductor to Equipment Not Equipped for Termination of Aluminum Conductor:
1. Prepare compression connection using an adapter Listed by UL for the purpose or by pigtailing a short length of suitable size of copper conductor to the aluminum conductor with a compression connector Listed by UL.
 2. Provide an insulating cover over adapter body or the compression connector.
 3. Terminate the adapter or the pigtail on to the equipment per manufacturer's recommendation.]IDENTIFICATION
- A. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Apply Sleeve and Sleeve Seal where raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies. Sleeve and Sleeve Seal materials and installation requirements are specified in Division 26 Section "Common Work Results for Electrical."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
1. Test insulation resistance for each feeder, and branch circuit.
 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors, and conductors of No. 2 AWG and larger for compliance with requirements.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for one minute.
- D. Perform continuity test to insure correct cable connection.
- E. Test Values
- a. Bolt-torque levels shall be in accordance with Table 1.1 thru Table 1.4, unless otherwise specified by the manufacturer.

Table 1.1 - Bolt Torque for Bus Connection using Cadmium or Zinc Plated Heat-Treated Steel

Grade	SAE 1 & 2	SAE 5	SAE 7	SAE 8
Minimum Tensile (P.S.I.)	64K	105K	133K	150K
Bolt Diameter (Inches)	Torque (Foot Pounds)			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1	225.6	372.8	528.0	571.2

Table 1.2 - Bolt Torque for Bus Connection using Silicon Bronze Fasteners ¹

	Non-Lubricated	Lubricated
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Bolt Diameter (Inches)	Torque (Foot Pounds)	
5/16	15.0	10.0
3/8	20.0	14.0
1/2	40.0	25.0
5/8	55.0	40.0
3/4	70.0	60.0

¹ Bronze alloy bolts with minimum tensile strength of 70,000 pounds per square inch.

Table 1.3 - Bolt Torque for Bus Connection using Aluminum Alloy Fasteners ²

Lubricated	
Bolt Diameter (Inches)	Torque (Foot Pounds)
5/16	8.0
3/8	11.2
1/2	20.0
5/8	32.0
3/4	48.0

² Aluminum alloy bolts with minimum tensile strength of 55,000 pounds per square inch.

Table 1.4 - Bolt Torque for Bus Connection using Stainless Steel Fasteners ³

Uncoated	
Bolt Diameter (Inches)	Torque (Foot Pounds)
5/16	14.0
3/8	25.0
1/2	45.0
5/8	60.0
3/4	90.0

³ Bolts, cap screws, nuts, flat washers, locknuts: 18-8 alloy. Belleville washers: 302 alloy.

- b. Minimum insulation-resistance values shall be not less than 50 megohms.
 - c. Investigate deviations between adjacent phases.
 2. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
 - a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each termination of or splice in cables and conductors No. 3 AWG and larger. Open or remove doors and covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Cables will be considered defective if they do not pass tests and inspections.
- G. Correct Deficiencies, Retest and Report:
1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Prepare a written report, certified by testing agency, to record the following:
 - a. Procedures used.

- b. Results that comply with requirements, identifying conductor, units, and devices checked.
- c. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- d. Observations and test results after remedial action.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. NFPA 70 and IEEE C2 include basic grounding requirements for electrical safety. This Section supplements the minimum safety requirements of the Code with requirements for additional grounding and with optional grounding methods and materials for both power and electronic systems.
- B. This Section includes methods and materials for grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.
- C. Related Sections include the following:
 - 1. Division 26 Section "Lightning Protection for Structures" for common ground bonding with lightning protection system.
 - 2. Division 27 Section "Grounding and Bonding for Communications Systems" for common ground bonding of Communications Systems including grounding bus.

1.2 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
 - 5. Grounding for sensitive electronic equipment.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:

1. Manufacturer's routine maintenance requirements for cables, terminations and all installed components.
2. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems and, test wells and ground rings based on NETA MTS.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - b. Include recommended testing intervals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.
- D. Comply with NFPA 70.
- E. Comply with NFPA 99.
- F. Comply with IEEE C2.
- G. Comply with ANSI-J-STD-607-A.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Burndy; Part of Hubbell Electrical Systems.
 2. Dossert; AFL Telecommunications LLC.
 3. ERICO International Corporation.
 4. Fushi Copperweld Inc.
 5. Galvan Industries, Inc.; Electrical Products Division, LLC.
 6. Harger Lightning and Grounding.
 7. ILSCO.
 8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
 9. Robbins Lightning, Inc.
 10. Siemens Power Transmission & Distribution, Inc.

2.2 CONDUCTORS

- A. Insulated Conductors: Tinned-Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 1. Solid Conductors: ASTM B 3.
 2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
8. Main Bonding Jumper: stranded copper conductors sized as indicated on Drawings.
9. Grounding Electrode Conductor: stranded copper conductors sized as indicated on Drawings.
10. Common Grounding Electrode Conductor: stranded copper conductors sized as indicated on Drawings.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, long barrel with at least two bolts.
 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.4 GROUNDING BUSBARS

- A. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm in cross section, 20 inches (500 mm) in length, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V, unless otherwise indicated.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 5/8 inch (16 mm) diameter by 120 inches (3000 mm), unless otherwise indicated.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Insulated stranded for all wire, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum.
 1. Bury at least 30 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal

inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inch minimum, from wall 12 inches above finished floor or 6 feet above transformer, unless otherwise indicated.
 - 2. Clean and apply anti-oxidant to the contact area prior to conductor connection.
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location as indicated on the Drawings. The electrode shall be connected to the frame of the generator.
- B. Dry-Type Transformers: Install an insulated grounding conductor from the common point of connection of the transformer secondary neutral point and the transformer enclosure to the following:
 - 1. The nearest grounding electrode per NFPA 70, including but not limited to building steel where available.
 - 2. The grounding bus of the common electrode grounding system, located in the electrical equipment room.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated

with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the edge of foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
 - 1. Bond to each device, box, and luminaire, unless otherwise indicated.
 - 2. Conduction insulation of the same rating as the phase conductors, for all feeders and branch circuits. Install the grounding conductors in the raceway with related phase and neutral conductors.
 - 3. Where parallel conductors in separate raceways occur, provide a grounding conductor in each raceway that meets requirements of NFPA 70.
- B. Enclosures: Install an insulated grounding conductor from grounding bushings to the frame of the enclosure, ground bus, and equipment grounding strap where each occurs. Install grounding bushings on all raceways connecting electrical enclosures constructed of separate enclosure panels, which are not integrally welded together.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including but not limited to air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway. Terminate at grounding conductor terminal on isolated ground bus of equipment of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway. Terminate at grounding conductor terminal on isolated ground bus of equipment of the applicable derived system or service, unless otherwise indicated.

3.6 INSTALLATION

- A. Provide permanent service neutral and equipment grounding in accordance with NFPA 70 and subject to the following additional requirements.
- B. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Connect the service neutral and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. Equipment grounds and the identified neutral of the wiring system shall not be interconnected beyond this point in the interior wiring system. From the common point of connection of the service neutral and the equipment ground, run in non-magnetic conduit a grounding electrode conductor without

joint or splice to the grounding electrode system and connect it with an approved bolted pressure clamp.

- D. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- E. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor a minimum of 30-inches below grade unless otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- F. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
 - 1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
 - 4. Where expansion joints or telescoping joints occur, provide bonding jumpers.
- H. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- I. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- J. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

- K. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each lightning protection down lead, extending around the perimeter of building.
 - 1. Install copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches from building foundation.
- L. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.7 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components as specified in Division 26 Section "Identification for Electrical Systems."

3.8 CONNECTIONS

- A. Ground Connections: Provide ground clamps or connectors of a suitable type for ground applications.
- B. Ground Bars: Irreversible bolted connector.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 4. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.

- C. Prepare test and inspection reports.
- D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
 - 1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 - b. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 - c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - d. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 - e. Substations and Pad-Mounted Equipment: 5 ohms.
 - f. Manhole Grounds: 10 ohms.
- E. Correct Deficiencies, Retest and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and rods as required to bring system into compliance.
 - 2. Prepare a written report, certified by testing agency, to record the following:
 - a. Procedures used.
 - b. Results that comply with requirements, identifying components checked.
 - c. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
 - d. Observations and test results after remedial action.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. **Related Sections include the following:**
 - 1. **Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.**

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. RAC: Rigid aluminum conduit.
- E. RMC: Rigid metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. RSC: Rigid Steel conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.

- B. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
 - C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.
 - 5. Concrete Based for Equipment.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Welding certificates.
- 1.7 QUALITY ASSURANCE
- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - B. Comply with NFPA 70.
- 1.8 COORDINATION
- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
 - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

- 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS
- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 - 2. Channel Dimensions: Selected for applicable load criteria.
 - B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
 - C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Device Box Mounting Brackets and Stabilizer: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper B-Line, Inc.
 - b. ERICO International Corporation.
- F. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper B-Line, Inc.
 - b. ERICO International Corporation.
- G. Roof-mounted Raceway Support Blocking: Factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line C-Port series components or a comparable product by one of the following:
 - a. Cooper B-Line, Inc.
 - b. ERICO International Corporation.
- H. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper B-Line, Inc.
 - b. ERICO International Corporation.
- I. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

- 5) MKT Fastening, LLC.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Solid, threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NFPA 70, NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except where requirements of this Section are more stringent.
- B. Maximum Horizontal and Vertical Support Spacing for Raceway(s): Space supports for EMT, IMC, and RMC as required by NFPA 70.
- C. Minimum Hanger Rod Size for Raceway Supports: Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- D. Single Raceways or Cables:
 1. For Raceways 1-1/4-inch (32mm) and smaller: Install adjustable steel band hanger suspended on threaded rod.
 2. For Raceways larger than 1-1/4-inch (30mm): Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods. Size trapeze members, including the suspension rods, based on the support required for the size, and loaded weight of the conduits.
 - a. Secure raceway or cable to support with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods, where multiple raceways are run vertically or horizontally at the same elevations. Size trapeze members, including the suspension rods, based on the support required for the number, size, and loaded weight of the conduits. Space them as required for the smallest conduit to be supported. Size so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NFPA 70, NECA 1 and NECA 101 for installation requirements except where requirements of this Article are more stringent.
- B. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.
- C. Install Device Box Mounting Brackets supported between two studs where boxes are not located adjacent to stud or where multiple boxes are located between studs.
- D. Install Device Box Stabilizer where single box is located adjacent to stud. Device Box shall not be supported by a single stud, but shall be positively attached to a support device between studs.
- E. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.
- F. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings.
 - 1. Install at least one independent support rod from box hanger to structure.
- G. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.
 - 1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work.
- H. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.
- I. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.
- J. Locate raceways so as not to hinder access to mechanical equipment.
- K. Do not secure conductors, raceways, or supports to suspended ceiling hanger rods or wires.
- L. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- M. Mounting and Anchorage of Surface-Mounted or Recessed-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or Spring-tension clamps.
6. To Light Steel: Sheet metal screws.
7. For Surface-Mounted Items on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to structure **by means that meet seismic-restraint strength and anchorage requirements**. Attachment to gypsum wall board is not acceptable as sole support means; slotted-channel rack solidly attached to structure or light-gauge metal framing at both ends is required.
8. For Recessed-Mounted Items in Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices to intermediate light-gauge metal framing members on each side of device or provide slotted-channel racks within hollow wall attached to **structure by means that meet seismic-restraint strength and anchorage requirements**. Attachment to gypsum wall board is not acceptable as sole support means.

N. Do not support any items (equipment, piping, conduit, etc.) exceeding 2 inches in diameter from the bottom of slabs. Where intermediate supports are required between structural members, use slotted steel channels support systems attached to beams or joists in order to avoid attachment to slabs.

O. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars. Verify reinforcing locations with Structural Engineer. X-Ray existing concrete structures as required.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 3 inches larger in all directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 1. **Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. Refer to Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.**

2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. All floor mounted equipment shall be provided with concrete base, unless otherwise indicated.
- 3.5 PAINTING
- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Surface raceways.
 - 4. Boxes, enclosures, and cabinets.
- B. Provide raceways and boxes for all the other systems, as specified in other Sections of Divisions 26, 27 and 28.
- C. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical non-metallic tubing.
- C. EPC: Electrical Plastic Conduit
- D. EPDM: Ethylene-propylene-diene terpolymer rubber.
- E. FMC: Flexible metal conduit.
- F. IMC: Intermediate metal conduit.
- G. LFMC: Liquidtight flexible metal conduit.
- H. LFNC: Liquidtight flexible nonmetallic conduit.
- I. NBR: Acrylonitrile-butadiene rubber.
- J. RAC: Rigid aluminum conduit.
- K. RMC: Rigid metal conduit.
- L. RSC: Rigid Steel conduit.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.

- B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- C. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Custom enclosures and cabinets.
 - 2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - a. Design Calculations: Calculate requirements for selecting seismic restraints.
 - b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical". Include the following:
 - 1. Raceway routing plans, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - a. Proposed cable pull points.
 - b. Structural members in the paths of conduit groups with common supports.
 - c. HVAC, plumbing items, and architectural features in the paths of conduit groups. Denote where systems share common supports.
 - d. Purposed splice locations.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store raceway components indoors to prevent water or other foreign materials from staining or adhering to components. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit.
 - 3. Anamet Electrical, Inc.

4. Electri-Flex Company.
 5. FSR Inc.
 6. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
 7. Patriot Aluminum Products, LLC.
 8. Picoma Industries.
 9. Republic Conduit.
 10. Robroy Industries.
 11. Southwire Company.
 12. Thomas & Betts Corporation.
 13. Western Tube and Conduit Corporation.
 14. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RSC: Comply with ANSI C80.1, UL 6, and NEMA FB 2.10; Galvanized rigid steel, each length with a coupling on one end and thread protector on opposite end.
- D. IMC: Comply with ANSI C80.6, UL 1242, and NEMA FB 2.10.
- E. Fittings for RSC and IMC: Provide factory made threaded couplings of same material as the conduit.
1. Molded thermoplastic insulating bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. In wet locations, provide watertight hubs for conduit entry into enclosures.
 2. Thermoplastic insulated grounding bushing on all conduits where grounding bushings are required, with locknuts inside and outside the enclosure. In wet locations provide watertight hubs for conduit entry into enclosures.
 3. Expansion joints: O-Z/Gedney or acceptable submission, with internal ground and external bonding jumper.
 - a. Expansion fitting: Type AX.
 - b. End type expansion fitting: Type EXE.
 - c. Deflection fitting: Type DX.
 - d. Pull box fitting: Type EXPB.
 - e. Combination expansion/deflection fitting: Type AXDX.
- F. Conduit fittings for Hazardous (Classified) Locations: Comply with UL 886.
- G. EMT: ANSI C80.3 and UL 797.
- H. Fittings for EMT:
1. Steel, set-screw couplings.
 2. Steel, set-screw insulated throat box connectors with molded thermoplastic insulating bushing at all boxes and cabinets, with locknuts inside box or cabinet.
 3. Steel, set-screw insulated throat box connectors with thermoplastic insulated grounding bushing on all tubing where grounding bushings are required.
 4. Expansion joints: O-Z/Gedney, type TX or acceptable submission, with internal ground and external bonding jumper.
 5. Insulated throat material for fittings to be of a color that is easily distinguishable; clear thermoplastic throats are not acceptable.
- I. FMC: Comply with UL 1; Zinc-coated steel.

- J. LFMC: Comply with UL 360; Flexible steel conduit with flame retardant PVC jacket and copper grounding strand.
- K. Fittings for FMC and LFMC: Comply with NEMA FB 1 and UL 514B.
 - a. Adapters at connections between flexible and rigid conduit.
 - b. Thermoplastic insulated throat, steel connectors at box or cabinet terminations.
 - c. Insulated throat material for fittings to be of a color that is easily distinguishable; clear thermoplastic throats are not acceptable.
- L. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
- M. Wire Support Bushings: Provide for vertical runs as required by the NFPA 70. Select for the conductor size involved.
 - 1. For conductors NO. 8 AWG and smaller provide galvanized, non-insulating type.
 - 2. For conductors No. 6 AWG and larger provide O-Z/Gedney, Type SR, insulating type.
- N. Joint Compound for RSC or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. Mono-Systems, Inc.
 - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, type and sized according to NFPA 70 as required.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 870.
- D. Fittings and Accessories:
 - 1. Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - 2. Construct wireways with/without knockouts, as required.
 - 3. Provide spring nuts or guards on all screws installed toward the inside to prevent wire insulation damage.
- E. Wireway Covers:
 - 1. Hinged type unless access restrictions require screw-cover type.
 - 2. Flanged-and-gasketed as required for NEMA type.
 - 3. Construct cover to close without the use of parts other than the standard lengths, fittings, and connectors.

4. Provide provisions for the cover to be sealed in the closed position with a sealing wire.

F. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers, complying with UL 5. Prime coating, ready for field painting.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A and manufactured of rigid PVC with texture and color selected by Architect from [manufacturer's standard] [custom] colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.
- D. Surface raceways used together with couplings, clips, bushings, straps, connectors, connection covers, elbows, boxes, extension boxes, fixture boxes, extension adapters, blank covers and all other required fittings; size to accommodate the conductors to be installed therein in each case.
- E. Tele-Power Poles:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. MonoSystems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
 2. Material: Propose to Owner option available with galvanized steel with ivory baked-enamel finish and Aluminum with clear anodized finish.
 3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Adalet.
 2. Cooper Technologies Company.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a brand of Pentair Equipment Protection.
 7. Hubbell Incorporated.
 8. Kraloy.
 9. Milbank Manufacturing Co.
 10. MonoSystems, Inc.
 11. Oldcastle Enclosure Solutions.
 12. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
 13. RACO; Hubbell.
 14. Robroy Industries.
 15. Spring City Electrical Manufacturing Company.
 16. Thomas & Betts Corporation.
 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes:
1. Material: Cast or sheet metal.
 2. Type: Fully adjustable or semi-adjustable.
 3. Shape: Rectangular or as indicated.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- I. Sheet Metal Pull and Junction Boxes: Comply with NEMA OS 1.
 - 1. Construct boxes from code gauge sheet steel no lighter than 14 gauge with overlapped riveted or welded corners and with edges turned to receive trim.
 - 2. Construct covers from same gauge as box with screw fasteners. Sectionalize boxes over 864 square inches.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- L. Gangable boxes are allowed.
- M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- N. Cabinets:
 - 1. Comply with NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Above Ground: RSC, or IMC.
 - 2. Within Crawl Spaces: RSC, or IMC.
 - 3. Emergency Feeders: RSC
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, unless otherwise indicated.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT, IMC for feeders.
 - a. Below 6'-0" AFF; IMC.
 - 2. Exposed and Subject to Physical Damage: RSC, or IMC. Includes, but is not limited to, raceways in the following locations:
 - a. Mechanical rooms.
 - 3. Conductors over 600 volts: RSC, or IMC.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Concealed within Masonry Walls: RSC, or IMC.
 - 6. Concealed under Raised Floors: EMT or LFMC.

7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 8. Flexible Connection to Luminaires on Normal System: FMC, maximum of 72 inches (1830 mm).
 9. Connection to Luminaires on Essential/Emergency System: RSC, IMC, or EMT.
 10. Flexible Connection to Luminaires on Emergency System: FMC, maximum of 72 inches (1830 mm).
 11. Damp or Wet Locations: RSC, or IMC.
 12. Elevator Pits: RSC, IMC, or LFMC.
 13. Emergency feeders and branch circuits: EMT, IMC for feeders.
- C. Minimum Raceway Size:
1. Individual Branch Circuits: 1/2-inch(16-mm).
 2. For feeder circuits and multiple branch circuits: 3/4-inch
- D. Provide minimum 1/2"-inch(16-mm) conduit for controls circuiting.
- E. Magnetic Resonance Imaging (MRI) Environments: Provide aluminum raceways within RF shielding.
- F. Use the shortest path possible to the intended load or receptacle for raceways of ungrounded circuits which are electrically monitored by ground detector system; this is intended to minimize leakage current to ground. In ceiling space, utilize paths that deviate from that perpendicular to structure where these paths will not interfere with other overhead systems.
- G. Junction and Pull Boxes: Sheet steel boxes, unless otherwise indicated.
1. Provide boxes no smaller than 4 inches square and 2-1/8 inches deep.
 2. Size all junction and pull boxes in accordance with the NFPA 70, unless project conditions dictate use of larger boxes.
 3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.
- H. Outlet and Device Boxes: Sheet steel boxes, unless otherwise indicated.
1. For Lighting Fixture Outlets: 4 inch square with raised fixture ring.
 2. For Wall Switches, Receptacles, and Communication Use: 4 inch square, one-piece. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use boxes 1-1/2 inch deep only in locations where deep boxes cannot be accommodated by construction.
 3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.
- I. Boxes Used Outdoors or in Damp/Wet Locations: Cast metal boxes with gasketed covers and threaded hubs.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Store conduit in dry locations during construction. Swab conduits out prior to pulling conductors.

- C. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel, unless intumescent putty pads are installed according to Division 07 Section "Penetration Firestopping."
- D. Locate boxes so that cover or plate will not span different building finishes.
- E. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- F. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- G. Set metal floor boxes level and flush with finished floor surface.
- H. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- I. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- J. Recessed Boxes in Fire-Rated Partitions: For boxes located on opposite sides of same partition do not install boxes back-to-back; separate boxes with a minimum of 24 inch separation, unless otherwise indicated in the installation requirements specified in Division 07 Section "Penetration Firestopping."
- K. Recessed Boxes in partitions around Acoustically-Sensitive Spaces: For boxes located on opposite sides of same partition do not install boxes back-to-back; separate boxes with a minimum of 24 inch separation. Acoustically-Sensitive Spaces include, but are not limited to, the following:
 - 1. Conference Rooms, Meeting rooms and similar spaces.
 - 2. Classrooms, Training Rooms and similar spaces.
 - 3. Interview Rooms, Consultation Rooms and similar spaces.
 - 4. Auditoriums, Lecture Rooms, and similar spaces.
 - 5. Ballrooms, Private Dining, and similar spaces.
 - 6. Other spaces specifically listed in the Project Acoustic Consultants' recommendation reports or specifications.
- L. On concealed conduit systems where boxes are not otherwise accessible, set boxes flush with finished surfaces for access, and provide overlapping covers.
- M. Provide boxes where shown and where necessary for the installation and pulling of cables and wires.
- N. Install covers on junction boxes and conduit bodies after wiring and connections are completed.
- O. Install raceways perpendicular or parallel to building surfaces with boxes set plumb and square. In areas where there are no suspended ceilings, run all conduits parallel and perpendicular to building surface planes.
- P. Install conduits to prevent excessive strain or damage to conductors.
- Q. Run conductors over 48 Volts in raceway, unless otherwise indicated.

- R. Where raceways are installed running parallel with flues, steam pipes, hot-water pipes, and other objects operating at high temperatures, maintain a minimum of 6 inches (150 mm) between raceway and pipe insulation or jacket.
- S. Where raceways cross hot water and steam piping, maintain a minimum of 1-inch (25.4-mm) between raceway and pipe insulation or jacket. Install horizontal raceway runs above water and steam piping.
- T. Complete raceway installation before starting conductor installation.
- U. Support raceways and boxes as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- V. Conceal conduit within finished walls, ceilings, and raised floors, unless otherwise indicated.
- W. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
 - 1. Change from ENT to RSC, or IMC before rising above the floor.
- X. No feeders or branch circuits are to be installed in any slab, unless otherwise indicated.
- Y. No branch circuits are to be installed below slab-on-grade, unless otherwise indicated. Exception: On-grade floor boxes, route raceway minimum of 6 inches below slab-on-grade.
- Z. Do not install aluminum conduits in contact with concrete.
- AA. Install no more than the equivalent of three 90-degree bends and a maximum of 150 feet between pull points in any conduit run except for communications conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- BB. Join RSC and IMC with threaded couplings. Ream conduits after threading and keep each end closed.
- CC. Join EMT with the specified type of couplings. At EMT terminations, provide insulated throat, box connectors and locknuts.
- DD. Provide insulating bushing at conduit box terminations. Provide bonding clamps where grounding bushings are required.
- EE. Secure rigid conduits at cabinets and boxes with galvanized locknuts, both inside and outside.
- FF. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- GG. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- HH. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- II. Install raceways to avoid moisture traps. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. In damp or wet locations.
 4. Where otherwise required by NFPA 70.
- JJ. Install raceways and cables as to not hinder access to ceiling space through access hatches. Maintain 36" minimum clearance and required clearance to equipment above ceiling access hatches.
- KK. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- LL. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- MM. Flexible Conduit Connections: Comply with NEMA RV 3.
1. Use minimum of 12 inches (305 mm) and a maximum of 72 inches (1830 mm) at final connections to equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 2. Use LFMC in damp or wet locations including mechanical equipment rooms, at motor or equipment locations at or near pumps, and when installed outdoors.
- NN. Where raceways do not terminate in a box or cabinet, install thermoplastic insulating bushings on end of raceway to protect future cabling from physical damage.
- OO. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

- PP. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- QQ. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- RR. Install pull wires free of splices in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Coil and identify each end of each line with plastic tag bearing complete information as to the purpose of the raceway and the location of its other end.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Apply Sleeve and Sleeve Seal where raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies. Sleeve and Sleeve Seal materials and installation requirements are specified in Division 26 Section "Common Work Results for Electrical."

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.5 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CONNECTIONS

- A. Ground raceways and boxes according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify raceways and boxes as specified in Division 26 Section "Identification for Electrical Systems".

3.8 SEGREGATION OF WIRING SYSTEMS

- A. Segregation of wiring systems shall not be compromised by the use of common pullboxes, wireways, cabinets or any other type of enclosure.
- B. The raceway system for each feeder shall be a separate system completely fault isolated from all other raceway systems.
- C. The raceway system for the branch circuits of each panelboard shall be a separate system completely fault isolated from all other raceway systems.

- D. In systems operating at more than 300 volts between phase conductors, and where different phase conductors are to be run to a common device or outlet box, provide code gauge barrier equal to box gauge between conductors so that two different phase wires will not be in the same compartment.

3.9 CLEANING

- A. On completion of raceway installation but before any cable is installed, perform the following:
 - 1. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. On completion of box, enclosure, and cabinet installation but before any cable or wiring devices are installed, inspect interior of boxes and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

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SECTION 260533.13

PATHWAYS FOR SPECIAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pathways for special systems as fully designed and defined by special systems, designers, engineers, and/or contractors as follows:
 - 1. Raceways, fittings, boxes, enclosures, and cabinets for special systems wiring.
 - 2. Non-continuous Angle Bracket Cable Supports (J-Hooks) for special systems wiring.
 - 3. Adjustable Cable Support Straps for special systems wiring.
 - 4. Steel or as defined by data-comm drawings, Aluminum cable trays and accessories for special systems wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction and for product requirements for common products referenced by this Section.
 - 2. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring and for product requirements for common products referenced by this Section.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. EPC: Electrical Plastic Conduit
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. NBR: Acrylonitrile-butadiene rubber.
- I. RAC: Rigid aluminum conduit.
- J. RMC: Rigid metal conduit.
- K. RSC: Rigid Steel conduit.
- L. Special Systems:

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: Include data indicating dimensions and finishes for each of the following:
 - 1. Conduit, tubing, surface raceways, wireways and fittings.
 - 2. Angle Brackets (J-Hooks), Wide-Base Cable Supports, and Adjustable Cable Support Straps.
 - 3. Cable trays.
- C. Shop Drawings: For each type of the following.
 - 1. Cable Tray: Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
 - a. Design Calculations: Calculate requirements for selecting seismic restraints.
 - b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical". Include the following:
 - 1. Pathway routing plans, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - a. Proposed path for raceways, including sizes and location of cable pull points.
 - b. Structural members in the paths of raceways, cabling support brackets and cable trays.
 - c. HVAC, plumbing items, and architectural features in the paths of raceways, cabling support brackets and cable trays. Denote where systems share common supports.
 - d. Vertical and horizontal offsets and transitions in pathway route.
 - e. Clearances for access above and to side of cabling support brackets and pathways.
 - f. Vertical elevation of cabling support brackets and cable trays above the floor or bottom of ceiling structure.

- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pathway components to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain pathway components through one source from a single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pathway components indoors to prevent water or other foreign materials from staining or adhering to components. Unpack and dry wet materials before storage.
 - 1. Cable tray shall be loosely stacked, elevated off the floor, and ventilated to prevent staining during storage.
 - 2. ~~[Steel cable tray, or Aluminum cable tray]~~ as defined on data Comm drawings. ~~[Stainless steel cable tray]~~ ~~[Fiberglass cable tray]~~ shall be stored to prevent water or other foreign materials from staining or adhering to cable tray.
 - 3. Steel, cable tray shall be stored in a well-ventilated, dry location.

PART 2 - PRODUCTS

2.1 METAL CONDUIT, TUBING, AND FITTINGS

- A. Refer to and comply with product specifications included in Division 26 Section "Raceways and Boxes for Electrical Systems" for conduit, tubing, and associated fittings and accessories.

2.2 NONMETALLIC CONDUIT, TUBING, AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corporation.
 - 6. Condux International, Inc.
 - 7. Electri-Flex Company
 - 8. Kraloy
 - 9. Lamson & Sessions.
 - 10. Niedax Inc.
 - 11. RACO; Hubbell.
 - 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Comply with NEMA TC 2 and UL 651, type EPC-40-PVC or type EPC-80-PVC as indicated.
- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

- F. LFNC: Comply with UL 1660.
- G. Fittings for LFNC: Comply with UL 514B.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Refer to and comply with product specifications included in Division 26 Section "Raceways and Boxes for Electrical Systems" for boxes, enclosures, cabinets, covers, and associated fittings and accessories.

2.4 METAL WIREWAYS

- A. Refer to and comply with product specifications included in Division 26 Section "Raceways and Boxes for Electrical Systems" for wireways, covers and associated fittings and accessories.

2.5 NONMETALLIC WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Allied Moulded Products, Inc.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. Lamson & Sessions.
 - 4. Niedax Inc.
- B. Listing and Labeling: Nonmetallic wireways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 SURFACE RACEWAYS

- A. Refer to and comply with product specifications included in Division 26 Section "Raceways and Boxes for Electrical Systems" for surface raceways, covers and associated fittings and accessories.

2.7 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Arnco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Comply with UL 2024; flexible type, approved for plenum riser and general-use installation, as required.

2.8 CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chalfant Manufacturing Company.
 - 2. Chatsworth Products, Inc.
 - 3. Cooper B-Line, Inc.
 - 4. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
 - 5. GS Metals Corp.; GLOBETRAY Products.
 - 6. MONO-SYSTEMS, Inc.
 - 7. MPHusky.
 - 8. PW Industries.
- B. Materials and Finishes: Cable Trays, Fittings, and Accessories:
 - 1. Steel: complying with NEMA VE 1.
 - a. [Factory-standard primer, ready for field painting; with cadmium-plated hardware according to ASTM B 766.]
 - b. [Mill galvanized before fabrication, complying with ASTM A 653/A 653M, G90 coating; with hardware [galvanized according to ASTM B 633]; [cadmium plated according to ASTM B 766].]
 - c. [Electrogalvanized before fabrication, complying with ASTM B 633; with hardware galvanized according to ASTM B 633.]
 - d. [Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, Class B2; with [chromium-zinc, ASTM F 1136.]; [Type 316 stainless-steel] hardware.]
 - e. [PVC coating applied in a fluidized bed or by electrostatic spray; with [chromium-zinc, ASTM F 1136]; [Type 316 stainless-steel] hardware.]
 - f. [Epoxy-resin paint over paint manufacturer's recommended primer and corrosion-inhibiting treatment; with [cadmium-plated hardware according to ASTM B 766]; [Type 316 stainless-steel hardware].]
 - 2. Aluminum: complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with [chromium-zinc, ASTM F 1136.]; [Type 316 stainless-steel] splice-plate fasteners, bolts, and screws]

- C. Sizes and Configurations: Refer to the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
 - 1. Center-hanger supports may be used only when specifically indicated.
- D. Cable Tray Accessories:
 - 1. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
 - 2. Covers: Louvered type of same materials and finishes as cable tray.
 - 3. Barrier Strips: Same materials and finishes as cable tray.

Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- E. Description:
 - 1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
 - 2. Materials: High-strength-steel longitudinal wires with no bends.
 - 3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
 - 4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch lengths.
 - b. Wire-Basket Depth: 1-inch usable loading depth by wide, unless otherwise noted on the drawings.
 - c. Wire-Basket Depth: 2-inch usable loading depth by required width as defined on Data Comm drawings wide.
 - d. Wire-Basket Depth: 4-inch usable loading depth by required width as defined on Data Comm drawings wide.
 - 5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
 - 6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
 - 7. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 Steel, zinc plated according to ASTM B 633.

2.9 WIRE-BASKET CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chalfant Manufacturing Company.
 - 2. Chatsworth Products, Inc.
 - 3. Cooper B-Line, Inc.
 - 4. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
 - 5. GS Metals Corp.; GLOBETRAYS Products.
 - 6. MONO-SYSTEMS, Inc.
 - 7. MPHusky.
 - 8. PW Industries.
- B. Description:
 - 1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
 - 2. Materials: High-strength-steel longitudinal wires with no bends.
 - 3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.

4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch lengths.
 - b. Wire-Basket Depth: 1-inch usable loading depth by required width as defined on Data Comm drawings wide.
 - c. Wire-Basket Depth: 2-inch usable loading depth by required width as defined on Data Comm drawings wide.
 - d. Wire-Basket Depth: 4-inch usable loading depth by required width as defined on Data Comm drawings wide.
5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 Steel, zinc plated according to ASTM B 633.

2.10 NON-CONTINUOUS ANGLE BRACKET CABLE SUPPORTS (J-HOOKS)

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Chatsworth Products, Inc.
 2. ERICO International Corporation.
 3. Panduit.
- B. Sizes and Configurations: Refer to the Drawings for specific requirements for types, sizes, and configurations.
- C. Individual Non-continuous Angle Bracket Cable Supports: Angle Bracket, Fittings, and Accessories:
 1. Bearing Surface Width: sufficient width to comply with required bend radii of high-performance cables.
 2. Edges: flared, to prevent damage while installing cables.
 3. Cable Retainer Strap: Supports sized 1 5/16" and larger, provide a cable retainer strap for containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 4. Materials and Finishes: Electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 5. Connectors: Manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips and treaded rod suspension accessories.
- D. Multi-tiered Non-continuous Angle Bracket Cable Supports: Angle Bracket, Fittings, and Accessories:
 1. Bearing Surface Width: sufficient width to comply with required bend radii of high-performance cables.
 2. Edges: flared, to prevent damage while installing cables.
 3. Cable Retainer Strap: Supports sized 1 5/16" and larger, provide a cable retainer strap for containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 4. Materials and Finishes: Electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 5. Connectors: Manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips and treaded rod suspension accessories.
 6. Bracket Assembly: Steel angled hanger bracket holding up to six individual non-continuous cable supports. Multi-tiered non-continuous angle bracket cable support

assemblies shall be used where separate cabling compartments are required. Factory-assembled or field-assembled from pre-packaged kits.

2.11 NON-CONTINUOUS ADJUSTABLE CABLE SUPPORT STRAPS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Chatsworth Products, Inc.
 - 2. ERICO International Corporation.
 - 3. Panduit.
- B. Sizes and Configurations: Refer to the Drawings for specific requirements for types, sizes, and configurations.
- C. Individual Non-continuous Adjustable Cable Support Straps: Straps, Fittings, and Accessories:
 - 1. Strap Capacity: Sling length can be adjusted to hold up to 425 4-pair UTP; Rated to support Category 5 and higher cable, or optical fiber cable. Static load limit of 100 lbs.
 - 2. Materials and Finishes: Constructed from steel and woven laminate; rated for indoor use in non-corrosive environments. Suitable for use in air handling spaces.
 - 3. Connectors: Manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips and treaded rod suspension accessories.

2.12 WARNING SIGNS

- A. Lettering: 1-1/2-inch-high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Materials and fastening are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 APPLICATION

- A. Pathways for Optical Fiber or Communications Cable. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed and Subject to Physical Damage: RSC. Includes, but is not limited to, raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - 2. Concealed within Masonry Walls: RSC, or IMC.
 - 3. Damp or Wet Locations: RSC.
 - 4. Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway.
 - 5. Concealed in wall or partition cavities: [Plenum-type, optical fiber/communications cable raceway][EMT][to the nearest accessible ceiling area].
 - 6. Concealed ceiling spaces: [Plenum-type, optical fiber/communications cable raceway] [EMT] [Plenum-type cable in Cable Tray] [Plenum-type cable suspended on J-hooks].

7. Exposed ceiling spaces (i.e. open structure): [Plenum-type, optical fiber/communications cable raceway] [EMT] [Plenum-type cable in Cable Tray] [Plenum-type cable suspended on J-hooks].
8. Spaces Used for Environmental Air: [Plenum-type, optical fiber/communications cable raceway] [EMT] [Plenum-type cable in Cable Tray] [Plenum-type cable suspended on J-hooks].
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

- B. Minimum Raceway Size:
 1. Optical Fiber or Communications Cable: 3/4-inch(21-mm)
 2. Controls Cable: 3/4-inch

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Comply with ANSI/EIA/TIA Standards 568 & 569,
- C. Comply with NFPA 70.
- D. Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.
- E. Comply with installation requirements for raceways and boxes in Refer to Division 26 Section "Raceways and Boxes for Electrical Systems" for products.
- F. Where raceways do not terminate in a box or cabinet, install thermoplastic insulating bushings on end of raceway to protect future cabling from physical damage.
- G. Install a blank cover plate on all outlet boxes.
- H. Install pull wires free of splices in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Coil and identify each end of each line with plastic tag bearing complete information as to the purpose of the raceway and the location of its other end.
- I. Install fire-rated plywood backboards as indicated in locations where special systems equipment is located. Backboards shall be mounted six (6") inches AFF and extend upward a full eight (8'-0") feet.
- J. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 1. Install raceways in maximum lengths of 75 feet between pull boxes.
 2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- K. Install individual raceways from special systems outlets boxes as follows, unless otherwise indicated:

1. Cables Concealed in wall or partition cavities to Concealed ceiling spaces: Route raceway in wall cavity to above nearest accessible ceiling. Extend raceway horizontally to within 12-inches of the cable pathway backbone.
2. Cables Concealed in wall or partition cavities to Exposed ceiling spaces: Route raceway in wall cavity to ceiling space and then turn horizontal and continue to the nearest cable pathway backbone or in conduit directly back to the termination room/closet for the special system.

3.3 OWNER FURNISHED SPECIAL SYSTEMS

- A. Coordinate pathways, raceways and box requirements and details of special system installation with shop drawings produced by the Owner's selected vendor.
- B. Vendor Furnished Boxes: Receive boxes from Owner's selected vendor and install in accordance with vendor shop drawings.
- C. Contractor Furnished Boxes for Owner Furnished Special Systems: Refer to shop drawings produced by Owner's selected vendor and provide pathways, raceways and boxes in accordance with vendor shop drawings.

3.4 CABLE TRAY INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Comply with ANSI/ EIA/TIA Standards 568 & 569,
- C. Comply with NFPA 70.
- D. Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.
- E. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
- F. Remove burrs and sharp edges from cable trays.
- G. Fasten cable tray supports to building structure **and install seismic restraints.**
 1. Design each fastener and support to carry load indicated by seismic requirements **and to comply with seismic-restraint details according to Division 16 26 Section "Vibration and Seismic Controls for Electrical Systems."**
 2. Place supports so that spans do not exceed maximum spans on schedules.
 3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 4. Support bus assembly to prevent twisting from eccentric loading.
 5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
 6. Locate and install supports according to NEMA.
- A. Support wire-basket cable trays with center support hangers trapeze hangers or wall brackets, as required by the Data Comm installation.

- B. Support center support hangers trapeze hangers for wire-basket trays with 1/4-inch or 3/8-inch diameter rods as required by the Data Comm installation.
- C. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.
- D. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA FG 1 or NEMA VE 1, as required. Space connectors and set gaps according to applicable standard.
- E. Make changes in direction and elevation using standard fittings.
- F. Make cable tray connections using standard fittings.
- G. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- H. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- I. Workspace: Install cable trays with enough space to permit access for installing cables.
- J. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- K. Install covers after installation of cable is completed as required by the Data Comm drawings.
- L. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

3.5 CABLE INSTALLATION

- A. Install cables only when pathway installation has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. On vertical runs, fasten cables to tray every 18 inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

3.6 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Apply Sleeve and Sleeve Seal where raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies. Sleeve and Sleeve Seal materials and installation requirements are specified in Division 26 Section "Common Work Results for Electrical."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

- A. Protect installed pathways.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray manufacturer.
 - 3. Install temporary protection for cables in pathways to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and pathways can be constructed of wood or metal materials until the risk of damage is over.

3.9 CONNECTIONS

- A. Ground cable trays according to manufacturer's written instructions assume #6 AWG copper insulated for the length of the tray, unless otherwise noted by the manufacturer.
- B. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.
- C. Ground raceways and boxes according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.10 IDENTIFICATION

- A. Identify raceways and boxes as specified in Division 26 Section "Identification for Electrical Systems".

3.11 FIELD QUALITY CONTROL

- A. After installing pathway components and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
 - 1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in pathway components, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 2. Verify that the number, size, and voltage of cables in pathways do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
 - 3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
 - 4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of pathway ventilation.
 - 5. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

- B. Report results in writing.

3.12 CLEANING

- A. On completion of raceway installation but before any cable is installed, perform the following:
 - 1. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. On completion of box, enclosure, and cabinet installation but before any cable or wiring devices are installed, inspect interior of boxes and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

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SECTION 260539

UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Flat-top, single- or multichannel, underfloor raceways.
 - 2. Flush, flat-top underfloor raceways.
 - 3. Cellular metal underfloor raceways.
 - 4. Trench-type underfloor raceways.
 - 5. Supports, raceway fittings, and hardware.
 - 6. Junction boxes.
 - 7. Service fittings.

1.2 DEFINITIONS

- A. Activation: Nomenclature used by some manufacturers for a service fitting.
- B. Flush Outlet: Underfloor raceway outlet installed so the top of the fixed portions of the receptacles, jacks, and connector assemblies is located approximately at the surface of the floor or floor covering, and with the bodies of connected plugs exposed above the surface of the floor.
- C. Flush Underfloor Raceway: Rectangular cross-section, flat-top raceway installed with the top of the raceway flush with the surface of the concrete in which it is embedded.
- D. Header Raceway: Rectangular cross-section, single-channel or multichannel, underfloor raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal components.
- E. Recessed Outlet: Underfloor raceway outlet installed with the top of the fixed portion of the connector assemblies located below the surface of the floor or floor covering and arranged to receive plug connectors with the bodies of the plugs concealed below the floor level.
- F. Service Raceway: Underfloor distribution raceway providing direct connection to service fittings using preset or afterset inserts.
- G. Trench Header: Trench-type raceway arranged as feeder raceway to bring wires and cables to service raceways from panelboards and communication terminal equipment.
- H. Underfloor Raceway: A conduit, duct, or cell assembly, or trench located within the floor material or with its top at the floor surface.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.

- B. Product Data: For each type of product.
 - 1. Include finishes, construction details, material descriptions, dimensions, and profiles for underfloor raceway components, fittings, and accessories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Shop Drawings: For underfloor raceways.
 - 1. Include floor plans, assembly drawings, sections, and details.
 - 2. Detail fabrication and assembly of underfloor raceways.
 - a. Identify components and accessories such as expansion-joint assemblies, straight raceway lengths, preset and afterset inserts, and service fittings.
 - b. Detail preparation and installation methods and instructions.
 - c. Provide dimensions locating raceway header and distribution elements. Include spacing between preset inserts and between preset inserts and ends of duct runs, walls, columns, junction boxes, and header duct connections.
 - d. Provide raceway fill charts for each duct size provided for each conductor size the duct is identified to accept. Provide separate charts for power and communication conductors and cables.
 - e. Show connections between raceway elements and relationships between components and adjacent structural and architectural elements including slab reinforcement, floor finish work, permanent partitions, expansion joints, architectural module lines, and pretensioning or post-tensioning components.
 - f. Indicate height of preset inserts, junction boxes, and raceways coordinated with depth of concrete slab and floor fill.
 - g. Indicate thickening of slabs where required for adequate encasement of raceway components.
 - h. Document coordination of exposed components with floor-covering materials to ensure that fittings and trim are suitable for indicated floor-covering material.
 - i. Revise locations from those indicated in the Contract Documents as required to suit field conditions and to ensure a functioning layout. Identify proposed deviations from the Contract Documents.
 - j. Show details of connections and terminations of underfloor raceways at conduit entry points.
 - k. Show details of connections and terminations of underfloor raceways at panelboards and communication terminal equipment in equipment rooms, wire closets, and similar spaces.
- D. Samples: For typical underfloor raceway products, in specified finish, including the following:
 - 1. Service fittings and flush and recessed outlet and junction-box covers.
 - 2. A section of each service raceway configuration with specified preset insert and service fitting installed.
 - 3. A junction box of each size and type for use with underfloor raceway.
 - 4. A section of each header raceway configuration, complete with provisions for connection with service raceway.
 - 5. A section of trench-type raceway, complete with cover and required trim.
 - 6. A junction box of each size and type, complete with cover and trim.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For underfloor raceways, to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
 - a. Manufacturer's written instructions for locating preset inserts and for installing afterset inserts.
- B. Project Record Documents: Submit final as-built Drawings, indicating dimensioned locations for all ducts, junction boxes, and preset inserts. Typical spacing designation shall be accepted only for preset insert spacing along a continuous length of duct.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 3. Service Fittings: Furnish <three> of each type of service fitting indicated for each 100 feet of distribution raceway or active-floor-cell length.
 - 4. Outlet Blanking Covers: Furnish quantity equal to one for every ten of each type of floor opening installed for outlets. Furnish at least one of each type.
- B. Furnish one electronic instrument and other tools, as recommended by underfloor raceway manufacturer for detecting, locating, and uncovering preset inserts in metal raceway under floor covering and up to 3/8 inch of concrete fill.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- B. Comply with UL 884.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 FLAT-TOP, STEEL UNDERFLOOR RACEWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. MonoSystems Inc.
 - 2. Square D; Schneider Electric.
 - 3. Thomas & Betts Corporation; A member of the ABB Group.
 - 4. Walker Systems, Inc.
- B. Description:
 - 1. Material: One-piece, continuous weld, minimum 0.0598-inch-thick steel, with corrosion-resistant galvanized coating inside and out after welding.
 - 2. Cross-Section Shape: Rectangular, with rounded corners.

1. Number of Longitudinal Channels: Two Three or Four, separated by steel wall(s).
 2. Number of Levels: One or Two as required.
 3. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch-minimum bending radius for communication cables.
- C. Service Raceways: Fitted with preset inserts.
1. Nominal Multichannel Underfloor Raceway Dimensions, unless otherwise indicated:
 - a. Depth: 1-3/8 inches.
 - b. Overall Width: 6 inches 10 inches 15 inches
 - c. Power Service Raceway:
 - 1) Width: 3-1/2 inches 4-3/8 inches .
 - d. Communication Service Raceway:
 - 1) Width: 3-1/2 inches 4 inches 6-1/2 inches.
 - 2) Number of Single-Channel Raceways per Run: One Two Three Four Five unless otherwise indicated.
 2. Preset Inserts: Rectangular Round.
 - a. Spacing: 24 inches 12 inches o.c.
 - b. Size: Rectangular dimensions as required to accommodate mounting and connection of flush- and surface-mounted, single- and multiple-outlet service fittings or to connect to wiring extensions for feeding wall outlets for powercommunicationspower and communications.
 - c. Size: 2 inches in diameter.
 - d. Equip each insert with a disposable cover and select insert height so cover is 1/8 inch below surface of concrete.
 - e. Arrange insert for optional attachment of flush-, surface-, or wiring- extension service fitting to replace disposable cover. Arrange brackets, mountings, barriers, and floor access covers to support, isolate, and provide access to flush or surface outlet-mounting connector, jack, and receptacle devices.
- D. Header Raceways: Single-Multichannel, without preset inserts (blank raceway).
1. Nominal Raceway Dimensions, unless otherwise indicated:
 - a. Depth: Same as service raceways 2-1/2 inches 2-3/4 inches 3 inches 3-1/2 inches.
 - b. Power Header Raceway Width: 3-1/2 inches 4-3/8 inches .
 - c. Communication Header Raceway Width: 3-1/2 inches 4 inches 6-1/2 inches.
 2. Arrangement: In same plane as Below service raceways.
 3. Connections: Arranged to connect with service raceways at single two-level junction boxes.

2.3 FLUSH, FLAT-TOP UNDERFLOOR RACEWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Walker Systems, Inc.
- B. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- C. Description:
1. Material: Steel.
 2. Cross-Section Shape: Rectangular, single channel and multichannel, separated by steel wall(s).
 3. Listed and labeled for installation with top flush with concrete floor.

4. Number of Levels: One.
- D. Service Raceways: Fitted with preset inserts.
1. Number of Longitudinal Channels per Multichannel Raceway: Two Three.
 2. Number of Single-Channel Raceways per Run: One Two Three unless otherwise indicated.
 3. Nominal Channel Dimensions: 3 inches wide by 1-1/4 inches deep.
 4. Preset Inserts: Threaded opening with removable steel plug that is flush with top of raceway when screwed in place.
 - a. Spacing: 24 inches 12 inches o.c., full length of each service raceway.
 - b. Arrangement: Stagger insert locations on parallel raceways or channels to accommodate placement of adjacent service fittings.
 - c. Size: 1-5/8-inch diameter.
- E. Trench Duct Crossunder: Fitting attached to underside of trench duct.
1. Nominal Channel Dimensions: Same as service raceways.
 2. Arrangement: Offset by depth of trench duct.
 3. Connections: Arranged to connect trench duct to flush duct through factory-cut, grommeted openings.
- F. Header Raceways: Raceways same as service raceways except without preset inserts (blank raceway).
1. Nominal Channel Dimensions: Same as service raceways.
 2. Arrangement: In same plane as service raceways.
 3. Connections: Arranged to connect with service raceways at junction boxes.
- 2.4 CELLULAR METAL UNDERFLOOR RACEWAYS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings <Insert manufacturer's name here> or a comparable product by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings <Insert Base Bid manufacturer's name here> as base bid. Provide alternate pricing in accordance with Division 01 Section "Alternates" for a comparable product by one of the following:
1. ASC Profiles, Inc.
 2. Dennis Filges Company, Inc.
 3. Epic Metals Corporation.
 4. HH Robertson.
 5. Thomas & Betts Corporation
 6. United Steel Deck Inc.
 7. Walker Systems, Inc.
- D. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- E. Description:
1. Material: Galvanized-steel sheet, ASTM A 653/A 653M, Structural Steel (SS), Grade 33 minimum, G60 G90 zinc coating.

2. Material: Galvanized- and shop-primed steel sheet, ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating; with underside surface cleaned, pretreated, and primed with manufacturer's standard gray white baked-on, rust-inhibitive primer.
 3. Number of Longitudinal Cells: Three, separated by steel walls.
 4. Nominal Dimensions of Cells:
 - a. Overall Depth: 1-1/4 inches unless otherwise indicated.
 - b. Cross-Sectional Area of Cells: Power cells: 5-1/2 sq. in.; communication system cells: 16 sq. in..
 5. Minimum Bending Radius for Communication Cables: Combination of raceways, fittings, inserts, junction boxes, service fittings, and mounting and connection arrangements for wiring devices and jacks shall provide a 2-inch-minimum bending radius for communication cables.
- F. Service Raceways: Fitted with preset inserts.
1. Preset Inserts: Rectangular-shaped metal housing assemblies arranged to provide electrical outlet access to each cell of each raceway designated for service raceway use. Inserts shall be provided throughout the entire length of each such raceway.
 - a. Spacing: 30 inches 24 inches 12 inches o.c.
 - b. Include housing and connecting provisions for a flush or recessed, single-, double-, or triple-system service fitting.
 - c. Include mounting and connecting provisions for a surface, single- or multiple-system service fitting.
 - d. Include connecting provisions for a wiring-extension service fitting to feed wall outlets.
 - e. Equip each insert with a disposable cover plate arranged for installation with top 1/8 inch below surface of concrete. Arrange insert to receive a flush-, recessed-, or wiring-extension service fitting to replace disposable top.
- G. Header Assembly: A junction box and raceway arrangement arranged to feed wires and cables to service raceways.
1. Three-compartment junction box connecting blank, multicell cellular flat-top, multichannel header raceway (no inserts) with cellular service raceways at right angles to header raceway.
 2. Cellular header raceway shall be made of the same material and have the same nominal dimensions as service raceways.
 3. Provide capability for service raceways to be run in both perpendicular directions at the intersection with header raceway.

2.5 TRENCH-TYPE UNDERFLOOR RACEWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings <Insert manufacturer's name here> or a comparable product by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings <Insert Base Bid manufacturer's name here> as base bid. Provide alternate pricing in accordance with Division 01 Section "Alternates" for a comparable product by one of the following:
1. Dennis Filges Company, Inc.
 2. HH Robertson.
 3. Square D.
 4. Thomas & Betts Corporation.

- 5. Walker Systems, Inc.
- D. Source Limitations: Obtain underfloor raceway components for each system through single source from single manufacturer.
- E. Trench: Steel, shop or factory welded and fabricated to indicated sizes. Include the following features:
 - 1. Slab Depth Adjustment: Minimum of minus 1/8 inch to plus 5/8 inch before and during concrete placement.
 - 2. Cover Supports: Height adjustable, with leveling screws to rigidly support cover assembly.
 - 3. Screed Strip: Extruded aluminum along both edges at proper elevation without requiring shim material.
 - 4. Trim Strip: Select to accommodate floor finish material.
 - 5. Partitions: Arranged to separate channels and isolate wiring of different systems.
 - 7. Manufacturer's standard corrosion-resistant finish, applied after fabrication.
- F. Cover Plates: Removable, steel plates, 1/4 inch thick, each weighing 60 lb or less with full gasket attached to side units. Fabricate intermediate supports to limit unsupported spans to 15 inches or less. Fabricate covers with appropriate depth recess to receive indicated floor finish.

2.6 SUPPORTS, RACEWAY FITTINGS, AND HARDWARE

- A. Source Limitations: Obtain underfloor raceway supports, fittings, and hardware components for each system through single source from single manufacturer.
- B. Supports, fittings, and hardware shall be compatible with raceway and outlet system and shall be listed for use with raceway systems and components delivered.
- C. Supports: Adjustable for height and arranged to maintain alignment and spacing of raceways during concrete placement. Include hold-down straps.
- D. Raceway Fittings: Couplings, expansion-joint sleeves, cross-under offsets, vertical and horizontal elbows, grounding screws, adapters, end caps, and other fittings suitable for use with basic components to form a complete installation.

2.7 JUNCTION BOXES

- A. Description: Manufacturer's standard enclosure for indicated type, quantity, arrangement, and configuration of raceways at each raceway junction, intersection, and access location. Include the following accessories and features:
 - 1. Mounting brackets.
 - 2. Escutcheons and holders to accommodate surrounding floor covering.
 - 3. Means for leveling and height adjustment more than 3/8 inch before and after concrete is placed.
 - 4. Boxes shall withstand a minimum 300-lb concentrated load. Internal supports shall be provided as needed to meet this requirement.
 - 5. All boxes shall provide 2-inch-minimum bend radius for data and communication cables.
 - 6. Raceway Openings: For underfloor raceways and conduits arranged to accommodate raceway layout.
 - 7. Covers shall have appropriate depth recess to receive specific floor finish material.
 - 8. Partitions to separate wiring of different systems.

2.8 SERVICE FITTINGS/ACTIVATIONS

- A. Exposed Parts Finish: Brass Brushed Aluminum.
- B. Flush, Single-System Service Fitting for Round Inserts: Include mounting and cover to support and provide access to single connector, jack, or receptacle device; mounted flush with floor within body of insert.
 - 1. Connector, Jack, and Receptacle Devices: Single modular type; complying with Division 26 Sections "Wiring Devices" and Division 27 "Communications Horizontal Cabling."
 - 2. Power Receptacle Outlet: Suitable for 20-A, 120-V device.
- C. Flush, Single- or Multiple-System Service Fitting for Rectangular Inserts: Include mounting, hinged cover, and trim to support and provide access to connector, jack, or receptacle devices mounted flush with floor within insert.
 - 1. Connector, Jack, and Receptacle Devices: Modular type; complying with Division 26 Sections "Wiring Devices" and Division 27 "Communications Horizontal Cabling."
 - 2. Power Receptacle Rating: 20 A, 120 V unless otherwise indicated.
- D. Recess-Mounted Service Fitting: Modular fittings compatible with preset inserts. Include device plates for indicated systems and provisions for receptacles, jacks, and connectors. Include hinged flush covers with recessed depth to match thickness of floor finish material. Provide for internally mounted receptacle- and communication-jack and connector assemblies complying with requirements in Division 26 Section "Wiring Devices" and Division 27 Section "Communications Horizontal Cabling."
 - 1. Duplex receptacle.
 - 2. Duplex telephone-data jacks.
 - 3. Double duplex receptacles.
 - 4. Duplex receptacle and duplex telephone-data jacks.
 - 5. Double duplex telephone-data jacks, Category 5 Category 5e Category 6.
 - 6. Fiber-optic cable connector.
- E. Surface-Mounted Service Fitting: Modular pedestal type, with locking attachment matched to insert floor opening.
 - 1. Power-outlet, double-faced, surface-mounted unit for duplex receptacle on both sides.
 - 2. Power-outlet, single-faced, surface-mounted unit for duplex receptacle on one side.
 - 3. Communication-outlet, double-faced, surface-mounted unit.
 - a. Include bushed openings on both sides; 1-inch minimum diameter; insulated with nonconducting material.
 - b. Include provisions for modular dual fiber-optic connector assembly on both sides.
 - c. Include provisions for modular dual jack-connector assembly, rated for Category 5 Category 5e Category 6, on both sides.
 - 4. Communication-outlet, single-faced, surface-mounted unit with bushed opening on one side; 1-inch minimum diameter; insulated with nonconducting material.
 - 5. Combination surface-mounted unit for duplex receptacle on one side and with communication cable connection provision on opposite side.
 - a. Communication Side: Include bushed opening; 1-inch minimum diameter; insulated with nonconducting material.
 - b. Communication Side: Include provisions for modular dual fiber-optic connector assembly.
 - c. Communication Side: Include provisions for modular dual jack-connector assembly, rated for Category 5 Category 5e Category 6.

- F. Flush-Mounted Service Fittings: Modular fittings compatible with preset inserts and shall include covers, provisions for receptacles jacks and connector assemblies and wiring extensions to wall-mounted outlets, and associated device plates for indicated systems. Include flush handhole covers, recessed to suit floor finish material. Internally mounted, modular, receptacle, jack and connector assemblies shall comply with requirements in Division 26 Sections "Wiring Devices" and Division 27 "Communications Horizontal Cabling."
1. Duplex convenience receptacle.
 2. Duplex telephone-data outlets.
 3. Double duplex convenience receptacles.
 4. Duplex convenience receptacle and duplex telephone-data outlets.
 5. Double duplex telephone-data outlets.
 6. Duplex communication jack, rated for Category 5Category 5eCategory 6.
 7. Duplex fiber-optic communication connector.
 8. Wiring-Extension Service Fittings: Arrangement of brackets and mountings to support, and provide access to wiring or cabling of a cell, and to connect the cable or raceway that extends the system to an individual wall outlet. Provide for connection of FMC ENT Type MC cable for power extensions, and FMC ENT optical fiber/communication cable raceway for communication system extensions.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to floor supports.
- B. Maintain arrangement of conductor services throughout the raceway system.
- C. Install a concrete mud slab for support of cellular metal, flush duct, or trench duct raceway. Construct mud slab with wire mesh in the top 1 inch of concrete.
- D. Install a vapor barrier between the cellular metal raceway and a substrate in contact with earth, in accordance with Division 07.
- E. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Fasten supports securely at ends and at intervals not to exceed 60 inches, to prevent movement during concrete pour.
- F. Level raceway components with finished slab and make adjustments in raceway component elevation to accommodate indicated floor finishes.
- A. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Grout boxes in place to prevent movement during construction. Place top covers in inverted position during construction to prevent damage to surface of cover. Reinstall covers in proper position prior to final acceptance of Work.

- B. Install preset inserts per manufacturer's instructions.
- C. Adjust supports to maintain a 1/8- to 3/8-inch finished concrete cover over preset inserts.
- D. Remove burrs, sharp edges, dents, and mechanical defects.
- E. Cap or plug boxes, insert- and service-fitting openings, and open ends of raceways.
- F. Install expansion fittings with suitable bonding jumper where raceways cross building expansion joints.
- G. Bond underfloor raceway components to create a continuous bonding path.
- H. Seal raceways, cells, junction boxes, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Tape joints, or seal with compound, as recommended in writing by underfloor raceway manufacturer.
- I. Ground underfloor raceway components.
- J. Install a marker at the center of the last insert of each cell and channel of each straight run of metal underfloor service raceway to locate the insert and identify the system.
 - 1. Install markers at last inserts on both sides of permanent walls and at first inserts adjacent to each junction box.
 - 2. Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommited screw when floor covering is placed. Do not extend through carpet.
 - 3. Use slotted-head screw to identify electrical power; use Phillips-head screw to identify conventional communications.
 - 4. Use another distinctive screw head to identify third system such as special-purpose wiring.
- K. Protect underfloor raceway system from damage. Do not use the installed duct system as working platforms or walkways. Do not allow equipment or heavy traffic over duct during construction period, without first installing ramps over the duct. Ramps shall be designed so that imposed loads are not transferred to the duct. Components of the system that are damaged during construction shall be replaced.
- L. Install concrete surrounding underfloor raceways according to Division 03 Section "Cast-in-Place Concrete."
- M. Afterset Inserts: Cut, hole saw, and drill slab and raceways to allow for installation at locations indicated on plans.
- N. Wiring shall comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" and NFPA 70 requirements for wet locations.
 - 1. Install wiring from outlet insert toward junction boxes, then to termination at panel.
 - 2. Splices: All splices and taps shall be made in junction boxes. No splices or taps shall be made in raceways or outlet inserts.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following field tests and inspections and prepare certified test reports:
- B. Perform the following field tests and inspections and prepare test reports with the assistance of a factory-authorized service representative:

1. Perform visual inspection of interior of each junction box or section of trench raceway to verify absence of dirt, dust, construction debris, and moisture. Replace damaged and malfunctioning components.
 2. Prior to and after concrete pour, perform point-to-point tests of ground continuity and resistance of ground path between the most remote accessible fitting on each branch of each underfloor raceway system and the main electrical distribution grounding system.
 - a. Determine cause and perform correction of any point-to-point resistance value that exceeds 0.05 ohms.
- C. Prepare test and inspection reports.
- 3.4 CLEANING
- A. Clean components according to manufacturer's written instructions.
- B. On completion of installation, inspect interior and exterior surfaces and perform the following:
1. Remove paint splatters and other spots.
 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 3. Repair exposed surfaces to match original finish.
 4. Swab out underfloor raceways, inserts, and junction boxes after finish has been applied to floor slab, and remove foreign material, dirt, and moisture. Leave interiors clean and dry.

END OF SECTION

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Direct-buried conduit, ducts, and duct accessories.
 - 2. Concrete-encased conduit, ducts, and duct accessories.
 - 3. Handholes and boxes.
 - 4. Manholes.
- B. Related Sections include the following:
 - 1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITION

- A. Duct: an underground raceway. This term may be used interchangeably with the term raceway.
- B. Duct Bank: two or more raceways grouped together, irrespective of duct material or encasement material.
- C. ENT: Electrical Non-Metallic Tubing
- D. EPC: Electrical Polyvinyl Chloride (PVC) Conduit
- E. RMC: Rigid metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. RSC: Rigid Steel conduit.
- H. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Warning tape.
 - 5. Warning planks.

- C. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans and elevations with dimensions and weights. Include sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder or Step details.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.
- D. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical". Include the following:
 - 1. Duct-Bank, Manhole, and Handhole plans, sections and elevation profiles; on which the following items are shown and coordinated with each other, passed on input from installers of the items involved:
 - a. Duct banks included in the Work. Denote duct routing including bends and locations of expansion fittings. Include system profiles and elevations.
 - b. Other utilities, underground structures, architectural features, and topographic elements in the paths of duct banks. Denote system profiles and elevations.
 - c. Precast or Factory-Fabricated Underground Utility Structures.
 - d. Factory-Fabricated Handholes and Boxes.
- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- C. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- D. Source quality-control test reports.
- E. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Accurately record actual routing of duct bank on Project record documents, and submit in accordance with Division 01.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical" and according to ASTM E 329.
- B. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Protect conduit from corrosion and entrance of debris by storing above grade with an appropriate covering. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.2 METAL CONDUIT AND DUCTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflec Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Electri-Flex Co.
 - 5. O-Z Gedney; a unit of General Signal.
 - 6. Manhattan/CDT/Cole-Flex.
 - 7. Wheatland Tube Company.
- B. RSC: Comply with ANSI C80.1 and UL 6; Galvanized rigid steel, each length with a coupling on one end and thread protector on opposite end.
- C. Fittings for RSC: Comply with UL 514B. Provide factory made threaded couplings of same material as the conduit.
 - 1. Molded thermoplastic insulating bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. In wet locations, provide watertight hubs for conduit entry into enclosures.
 - 2. Thermoplastic insulated grounding bushing on all conduits where grounding bushings are required, with locknuts inside and outside the enclosure. In wet locations provide watertight hubs for conduit entry into enclosures.

2.3 NONMETALLIC CONDUIT AND DUCTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. CANTEX INC.
 - 4. CertainTeed Corporation.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.

8. IPEX USA LLC.
9. Lamson & Sessions.
10. Manhattan CDT.
11. Spiraduct/AFC Cable Systems, Inc.

- B. ENT: Comply with NEMA TC 13.
- C. RNC: Comply with NEMA TC 2 and UL 651, type EPC-40-PVC or type EPC-80-PVC as indicated.
- D. Fittings for ENT and RNC: Comply with NEMA TC 3 and UL 651; match to conduit or tubing type and material.

2.4 DUCT ACCESSORIES

- A. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
- B. Corrosion Resistance Tape for RSC: 20 mil polyvinyl chloride (PVC) tape with a high-tack adhesive and pipe primer to provide a corrosion- and impact-resistant seal.
- C. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
- D. Warning Caps: Cast-in-Place Cap or multiple manufactured Planks.
 1. Cast-In-Place Cap: 6000-psi (41-MPa) minimum 3-inches (76 mm) thick concrete meeting the requirements of Division 03 "Cast-In-Place Concrete".
 - a. Color: Dye added to concrete during batching or powder dye applied to top prior to curing.
 - 1) ELECTRIC: Red for duct systems with power wires and cables.
 - 2) SIGNAL: Orange for communications, data, and telephone duct systems
 - b. Label top of encased duct bank with stenciled lettering 2-inch- (50-mm-) high letters at not less than 10-foot intervals, after curing. Label selected to suit system or as otherwise required.
 - 1) Legend: "ELECTRIC-LV" for duct systems with power wires and cables operating at 600 V and less.
 - 2) Legend: "ELECTRIC-HV" for duct systems with power wires and cables operating over 600 V.
 - 3) Legend: "SIGNAL" for communications, data, and telephone duct systems.
 2. Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 75 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
 - a. Color: Dye added to concrete during batching.
 - 1) ELECTRIC: Red for duct systems with power wires and cables.
 - 2) SIGNAL: Orange for communications, data, and telephone duct systems.
 - b. Label top of each plank with lettering 2-inch-high, 3/8-inch-deep letters. Label selected to suit system or as otherwise required.
 - 1) Legend: "ELECTRIC-LV" for duct systems with power wires and cables operating at 600 V and less.
 - 2) Legend: "ELECTRIC-HV" for duct systems with power wires and cables operating over 600 V.

- 3) Legend: "SIGNAL" for communications, data, and telephone duct systems.

2.5 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Christy Concrete Products.
 2. Elmhurst-Chicago Stone Co.
 3. Oldcastle Precast, Inc.
 4. Rinker Group, Ltd.
 5. Riverton Concrete Products.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
1. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 3. Cover Legend: Molded lettering, selected to suit system or as otherwise required.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with power wires and cables operating over 600 V.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 4. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth as required.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
 7. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.

- b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
- 9. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 - 1. Color: Gray for paved areas and Green for landscaped areas, unless otherwise indicated.
 - 2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, selected to suit system or as otherwise required.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with power wires and cables operating over 600 V.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 - 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 - 7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 PRECAST MANHOLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast Group.
 - 5. Rinker Group Ltd.
 - 6. Riverton Concrete Products.
 - 7. Utility Concrete Products, LLC.
 - 8. Utility Vault Co.
 - 9. Wausau Tile Inc.
- B. ANSI/ACI 301 - Specifications for Structural Concrete for Buildings.
- C. ANSI/ASTM A615 - Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- D. AASHTO HS-20 - Standard Specification for Highway Bridges.
- E. Comply with ASTM C 858.
- F. Structural design loading: Comply with requirements in Part 3 "Underground Enclosure Application" Article

- G. Precast Manholes: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
 - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- H. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- I. Ground Rod Sleeve: Provide a 3-inch PVC conduit sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.
- J. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.8 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858 and with Division 03 Section "Cast-in-Place Concrete."
- C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.9 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Bilco Company (The).
 - 2. Campbell Foundry Company.
 - 3. Cander Concrete Products.
 - 4. Christy Concrete Products.
 - 5. East Jordan Iron Works, Inc.
 - 6. Elmhurst-Chicago Stone Co.
 - 7. McKinley Iron Works, Inc.
 - 8. Neenah Foundry.
 - 9. NewBasis.
 - 10. Oldcastle Precast, Inc.

11. Osburn Associates, Inc.
 12. Pennsylvania Insert Corporation.
 13. Quazite: Hubbell Power Systems, Inc.
 14. Rinker Group, Ltd.
 15. Riverton Concrete Products.
 16. Underground Devices, Inc.
 17. Utility Concrete Products, LLC.
 18. Utility Vault Co.
 19. Wausau Tile Inc.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B or cast aluminum with milled cover-to-frame bearing surfaces; diameter, 29 inches (725 mm).
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.
- E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- G. Ground Rod Sleeve: 3-inch, PVC conduit sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.
- H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

- I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
 - J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Capable of withstanding maximum hydrostatic pressures at the installation location with the ground-water level at grade.
 - K. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
 - L. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.
- 2.10 SOURCE QUALITY CONTROL
- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 - B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Division 31 Section "Site Clearing." Remove and stockpile topsoil for reapplication according to Division 31 Section "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank with warning tape, unless otherwise indicated. RSC, wrapped with corrosion resistance tape, in duct bank with warning tape. RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank with warning tape.
- B. Ducts for Electrical Services 600 V and Less: Provide the following, unless otherwise indicated:
 - 1. Outside building footprint: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank with warning tape. RSC, wrapped with corrosion resistance tape, in duct bank with warning tape. Outside building footprint: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank with warning tape.
 - 2. Under building slab: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank with warning tape, minimum 12 inches below slab.
- C. Ducts for Electrical Feeders 600 V and Less: Provide the following, unless otherwise indicated:
 - 1. Outside building footprint: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank with warning tape. ~~Outside building footprint: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank with warning tape.~~
 - 2. Under building slab: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank with warning tape, minimum 12 inches below slab.
- D. Ducts for Electrical Branch Circuits 600 V and Less: Provide the following, unless otherwise indicated:
 - 1. Outside building footprint: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank with warning tape.
 - 2. Under building slab, where permitted: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank with warning tape, minimum 12 inches below slab.
 - a. No branch circuits are to be installed below slab-on-grade, unless otherwise indicated. Exception: On-grade floor boxes, route raceway minimum of 6 inches below slab-on-grade.
- E. Ducts for Emergency or Essential Electrical System Feeders 600 V and Less: Provide the following, unless otherwise indicated:
 - 1. Outside building footprint: RNC, NEMA Type EPC-80-PVC, in direct-buried with warning tape. RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank with warning tape. RSC, wrapped with corrosion resistance tape, in duct bank with warning tape.
 - 2. Under building slab: RNC, NEMA Type EPC-40-PVC, in concrete encased duct bank with warning tape. RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank with warning tape, minimum 12 inches below slab. RSC, wrapped with corrosion resistance tape in direct-buried duct bank with warning tape, minimum 12 inches below slab.
- F. Ducts for Emergency or Essential Electrical System Branch Circuits 600 V and Less: Provide the following, unless otherwise indicated:
 - 1. Outside building footprint: RNC, NEMA Type EPC-80-PVC, in direct-buried with warning tape. Under building slab, where permitted: RSC, wrapped with corrosion resistance tape in direct-buried duct bank with warning tape, minimum 12 inches below slab.
 - a. No branch circuits are to be installed below slab-on-grade, unless otherwise indicated. Exception: On-grade floor boxes, route raceway minimum of 6 inches below slab-on-grade.

- G. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank with warning caps and warning tape, unless otherwise indicated.
- H. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank with warning tape, unless otherwise indicated.
- I. Underground Ducts Crossing or Routed Beneath Paved Paths, Walks, Driveways, and Roadways: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank with warning tape.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Manholes: Precast or cast-in-place concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving", but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and re-establish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."
- E. Prepare excavation, base material installation, and compaction necessary for the specific ductbank arrangement.
- F. Verify that excavation, base material installation, and compaction is completed.
- G. Backfill trenches as specified in Division 31.

3.5 DUCT INSTALLATION

- A. Install ducts according to NEMA TCB 2.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- C. Curves and Bends:
 - 1. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1200 mm, both horizontally and vertically, at other locations, unless otherwise indicated.
 - 2. Where RNC is provided, use RSC elbows with corrosion resistance tape and primer for all bends.
- D. Install conduits to locate top of ductbank at depths as indicated or as required to coordinate with other portions of the Work.
- E. Apply corrosion resistance tape and primer to direct-buried or concrete-encased RSC.
- F. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- G. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct banks with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical/Common Work Results for Communications/Common Work Results for Electronic Safety and Security."
- I. Stub-Ups: Use manufactured rigid steel conduit elbows and rigid steel conduit extensions for stub-ups at poles, equipment, and at building entrances through the floor. Install insulated bushings on terminations.
 - 1. Where RNC is permitted, convert to RSC prior to turning up into equipment.
 - 2. Extend conduit extensions installed in floors a minimum of 4 inches above finished floor level.
 - 3. Extend conduit extensions installed in equipment bases a minimum of 4 inches above finished base level.
 - 4. Stub-Ups to Outdoor Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit below base horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

- J. Sealing: Provide temporary caps to protect installed conduit against entrance of dirt and moisture prior to cable installation. Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- K. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares.
- L. Concrete-Encased Duct(s) and Duct Banks: Support ducts on duct separators.
 - 1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
 - 2. Width: Excavate trench 12 inches wider than duct bank on each side.
 - 3. Depth: Install top of duct bank as follows, unless otherwise indicated.
 - a. Ducts for Electrical Cables Over 600 V: at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 24 inches below finished grade in deliberate traffic paths for vehicles.
 - b. Ducts for Electrical Conductors and Cables 600 V and less: at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles.
 - 4. Support duct(s) on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - a. Provide Field-Fabricated duct separators for conduits less than 2 inches (50 mm).
 - b. Provide Pre-Manufactured duct separators for conduits 2 inches (50 mm) and larger.
 - c. Required duct separators may be omitted within 2 feet (600 mm) of stub-up location.
 - 5. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 - 7. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Stub Ups: Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 8. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 - 9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 - 10. Concrete Color: Dye added to concrete during batching or powder dye applied to top prior to curing.
 - a. ELECTRIC: Red for duct systems with power wires and cables.
 - b. SIGNAL: Orange for communications, data, and telephone duct systems.

11. Concrete Cover: Install a minimum of 3 inches of concrete cover at top and bottom, and a minimum of 2 inches on each side of duct bank, unless otherwise indicated.
 12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - c. For Cast-In-Place manholes: Connect to manhole wall using dowels.
 13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Division 3 Section "Cast-in-Place Concrete." Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 14. Comply with requirements in Division 31 Section "Earth Moving" for installation of backfill materials.
 - a. Place minimum 6 inches of engineered fill above concrete encasement of duct bank.
 15. Label top of encased duct bank with stenciled lettering 2-inch- (50-mm-) high letters at not less than 10-foot intervals, after curing. Label selected to suit system or as otherwise required.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with power wires and cables operating over 600 V.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
- M. Direct-Buried Duct(s) and Duct Banks:
1. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
 2. Support duct(s) on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - a. Provide Field-Fabricated duct separators for conduits less than 2 inches (50 mm).
 - b. Provide Pre-Manufactured duct separators for conduits 2 inches (50 mm) and larger.
 - c. Required duct separators may be omitted within 2 feet (600 mm) of stub-up location.
 3. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
 4. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
 5. Set elevation of bottom of duct bank below frost line.

6. Minimum Space between Ducts: 3 inches between ducts for like services, and 6 inches between power and signal ducts.
 7. Elbows: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment, at building entrances through floor, and at changes of direction in duct run.
 - a. Stub Ups: Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
 8. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".
 - a. Place minimum 3 inches of sand as a bed for duct bank. Place sand to a minimum of 6 inches above top level of duct bank.
- N. Warning Caps: Install Cast-In-Place Caps or Manufactured Planks approximately 12 inches above direct-buried ducts and duct banks, where indicated.
1. Cast-In-Place Caps: Place to cover entire width of duct bank.
 2. Warning Planks: Place planks 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.
- O. Warning Tape: Bury Warning Tape approximately 12 inches above ducts and duct banks, where indicated.
1. Align tape parallel to and within 3 inches of the centerline of duct bank.
 2. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-Place Manhole Installation:
1. Finish interior surfaces with a smooth-troweled finish.
 2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick. Repair all unused conduit knockouts and other openings in sides of manhole.
 3. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
- B. Precast Concrete Handhole and Manhole Installation:
1. Comply with ASTM C 891, unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a minimum 6-inch (150-mm) level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade or as required to prevent floating of manhole.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 3. Install handholes with bottom below the frost line.
 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
 5. Where indicated, cast handhole cover frame integrally with handhole structure.
- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions as indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings to support cast-iron frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing" or "Thermoplastic Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- K. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.
- 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE
- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

- B. Unless otherwise indicated, support units on a minimum 4-inch (100-mm) level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and other non-concrete surfaces and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.9 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Apply Sleeve and Sleeve Seal where raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, exterior walls, sub-grade walls or fire-rated floor and wall assemblies. Sleeve and Sleeve Seal materials and installation requirements are specified in Division 26 Section "Common Work Results for Electrical."

3.10 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a 6-inch-(150-mm-) long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.11 CLEANING

- A. On completion of installation but before any equipment or cable is installed, inspect interior and exterior surfaces and perform the following:
 - 1. Clean ducts prior to cleaning manhole or pull box.
 - 2. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
 - 3. Remove all dirt and debris and pump out the manhole or pull box so that it is free of standing water. Manholes and pull boxes shall be dry prior to equipment or cable is installed.
 - 4. Clean internal surfaces of manholes, including sump and remove foreign material.
 - 5. Repaired of damages resulting from construction after initial installation.

END OF SECTION

SECTION 260548

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Delegated Design requirements for system design.
 - 2. Requirements for Manufacturer Seismic Certification.
 - 3. Requirements for Manufacturer Special Seismic Certification.
 - 4. Isolation pads.
 - 5. Spring isolators.
 - 6. Restrained spring isolators.
 - 7. Channel support systems.
 - 8. Restraint cables.
 - 9. Hanger rod stiffeners.
 - 10. Anchorage bushings and washers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. Seismic Certification: Seismic certification refers to a manufacturer's certification for architectural, mechanical, and electrical components, supports, and attachments pursuant to ASCE/SEI 7-05 Section 13.2.1.2.
- D. Seismic Qualification: Same as Special Seismic Certification
- E. Special Seismic Certification: Seismic certification of mechanical and electrical equipment based on ASCE/SEI 7-05 Section 13.2.2. Special Seismic Certification is required for active mechanical and electrical equipment that must remain operable following the design earthquake.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for vibration and seismic controls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Do not use more than one pre-approved seismic-force resistance system on any single run of pipe, duct or conduit. Mixing of multiple pre-approved systems is not acceptable.
- B. Seismic-Restraint Loading: In preparation of Delegated Design, utilize seismic forces as described in ASCE 7-02 "Minimum Design Loads for Buildings and Other Structures" as

published by the American Society of Civil Engineers, unless requirements in this Section are more stringent. Refer to the structural engineers drawings for confirmation of the following criteria.

1. Site Class as Defined in the IBC.
 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: Per ASCE 7-10 Section 13.1.3.
 - b. Component Response Modification Factor: Per ASCE Table 13.6-1.
 - c. Component Amplification Factor: Per ASCE Table 13.6-1.
 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.138g.
 4. Design Spectral Response Acceleration at 1.0-Second Period: 0.088g.
- C. Submittal Review Conference: At time of Delegated Design Shop Drawing submission, schedule a submittal review conference with the Architect and Structural Engineer-of-Record for the project. The purpose of this conference is to review attachment locations and insure supplementary framing that is needed to resist the loads, maintain stability or to meet other installation requirements of a pre-approved system have been accounted for in the Structural Engineer-of-Record's design.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS
- B. General Submittal Requirements:
1. Submittals shall be reviewed by Architect and the Structural Engineer-of-Record prior to submitting them to authorities having jurisdiction.
- C. Contractor Statement of Responsibility:
1. Submit a written statement in accordance with IBC Chapter 17.
 2. Statement shall be submitted on company letterhead.
 3. In instances where trade sub-contractors are responsible for construction and implementation of seismic-force resisting systems, the representatives of these various trade sub-contractors shall sign the Contractor Statement of Responsibility.
- D. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- E. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

- a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer and testing agency.
- C. Common Requirements For Qualification Data:
 1. Manufacturer Seismic Qualification Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in this Section. Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 2. Manufacturer Special Seismic Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in this Section. Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

- b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Welding certificates.
- E. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For seismic-force restraint systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Copy of the Delegated Design Shop Drawings, including AHJ approval stamp.
 - 2. Copy of the Delegated Design Submittal, including AHJ approval stamp.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC NFPA 5000 and CBC, unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Special Seismic Certification: Unless otherwise allowed by OSHPD, electrical components, supports, and attachments shall be certified pursuant to ASCE/SEI 7-05 Section 13.2.2. Items requiring certification are as follows, but not limited to:
 - 1. Emergency and standby power systems, including, but not limited to:
 - a. Generators.
 - b. Fuel tanks.
 - c. Automatic Transfer Switches.
 - 2. Switchboards.
 - 3. Transformers.
 - 4. UPS and associated batteries.
 - 5. Distribution panels including electrical panelboards.
 - 6. Control panels, including but not limited to:
 - a. Fire Alarm.
 - b. Auxiliary.
 - c. Remote Power Supplies.

- F. Rugged Equipment: Factory assembled, discrete components are considered rugged and deemed to comply with ASCE/SEI 7-05 Section 13.2.6, and do not require Special Seismic Certification. Items considered exempt are as follows:
1. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE/SEI 7-05, as modified by Section 1614A, 2007 CBC.
- G. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. ISAT, International Seismic Application Technology.
 5. Isolation Technology, Inc.
 6. Kinetics Noise Control.
 7. Mason Industries.
 8. Vibration Eliminator Co., Inc.
 9. Vibration Isolation.
 10. Vibration Mountings & Controls, Inc.
- B. Isolation Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant pads of neoprene, rubber or hermetically sealed compressed fiberglass minimum 1/4 inch thick.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. ISAT, International Seismic Application Technology
 5. Hilti Inc.
 6. Loos & Co.; Seismic Earthquake Division.
 7. Mason Industries.
 8. TOLCO Incorporated; a brand of NIBCO INC.
 9. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least 4 times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized -steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners as required by delegate design calculations to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.
- D. Provide vibration isolation for floor-mounted and rack mounted transformers as follows:
 - 1. 45 kVA and below: provide nothing.
 - 2. 75 kVA to 150 kVA: provide isolation pad.
 - 3. 225 kVA and above: provide spring isolators.
- E. Provide spring isolators for suspended transformers.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators as required by delegate design calculations.

2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 IDENTIFICATION

- A. Install brass identification tags at all seismic brace locations. Tags to include the following information:
1. Unique keyed identification number that corresponds to nomenclature used to mark location on shop drawings and calculations.
 2. Specific G-force the system at that location is designed to resist.
 3. Maximum brace reaction to the structure.
 4. For Individually suspended items: Maximum conduit size.
 5. For Trapeze or Multiple pipe hangers: Maximum pounds-per-lineal-foot.
 6. For Suspended Equipment: Maximum weight of equipment.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
- ~~B. [Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following field tests and inspections and prepare certified test reports:]~~
- C. ~~[Perform the following field tests and inspections and prepare test reports:]~~
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
- D. Correct Deficiencies, Retest and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace units and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
 - 4. Prepare a report, certified by testing agency, that identifies unit components and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.7 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.8 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. Equipment: Provide equipment name and/ or description:
 - 1. Emergency Feeders and branch circuits.
 - 2. Normal Feeders and branch circuits
 - 3. Cable Trays
 - 4. Lights
 - 5. Dimming Panels

6. Medium-Voltage Transformers
7. Low-Voltage Transformers
8. Switchboards
9. Panelboards
10. Motor-Control Centers
11. Enclosed Bus Assemblies
12. Enclosed Switches And Circuit Breakers
13. Enclosed Controllers
14. Variable-Frequency Motor Controllers
15. Engine Generators
16. Static Uninterruptible Power Supply
17. Transfer Switches
18. SPD For Low-Voltage Electrical Power Circuits

B. Equipment: Provide equipment name and/ or description.

1. Equipment Location: (Insert room number).
2. Pads:
 - a. Material: Neoprene Rubber or Hermetically sealed compressed fiberglass.
 - b. Thickness: (Insert inches).
 - c. Durometer: (Insert number).
 - d. Number of Pads: (Insert number) thick.
3. Isolator Type: Insert generic name or designation used in Part 2.
4. Component Importance Factor: As determined per ASCE.
5. Component Response Modification Factor: As determined per ASCE.
6. Component Amplification Factor: As determined per ASCE.

C. Equipment: Provide equipment name and/ or description.

1. Emergency Feeders and branch circuits.
2. Normal Feeders and branch circuits
3. Cable Trays
4. Lights
5. Dimming Panels
6. Medium-Voltage Transformers
7. Low-Voltage Transformers
8. Switchboards
9. Panelboards
10. Motor-Control Centers
11. Enclosed Bus Assemblies
12. Enclosed Switches And Circuit Breakers
13. Enclosed Controllers
14. Variable-Frequency Motor Controllers
15. Engine Generators
16. Static Uninterruptible Power Supply
17. Transfer Switches
18. SPD For Low-Voltage Electrical Power Circuits

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceways.
 - 2. Identification for conductors and multi-conductor cables.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for engraved wall plates and wiring device identification requirements.

1.2 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each electrical identification product indicated.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- D. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1[and IEEE C2].
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. [Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.]

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams,

and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Color for Raceways Carrying Circuit at 600V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type, if applicable.
- C. Colors for Raceways Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."
- D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 MULTI-CONDUCTOR CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Colors for Cables Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Colors for Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER HIGH VOLTAGE WIRING."
- D. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Brass or Stainless Steel Wraparound Marker Labels: Cut from 0.014-inch-thick, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or Stainless Steel, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 1. Not less than 6 inches wide by 4 mils thick.
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend shall indicate type of underground line.

2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for interior application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for exterior application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR ## INCHES." Verify work space required for specific project conditions with NFPA 70 and replace "##" in previous sentence with appropriate distance.
 3. Arc Flash Warning and Instructions: "WARNING – ARC FLASH AND SHOCK HAZARD. WEAR APPROPRIATE PPE. Determine appropriate protective clothing and personal protective equipment (PPE) for the task from NFPA 70E."
 4. Provide detailed labeling in accordance with requirements listed in Division 26 Section "Overcurrent Protective Device Coordination Study".

2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 ONE-LINE DIAGRAM NAMEPLATE

- A. Preprinted engraved, laminated acrylic or melamine plastics sign. Nominal size, 12 by 12 inches 1/8 inch (3.2 mm) thick. Engraved legend with black letters on white face. Image on sign depicting equipment components in single-line diagram format, using symbols and letter designations consistent with final one-line bus diagram. Produce a concise visual presentation of principal equipment components and connections.

2.8 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Adhesive, Punched, or drilled for screw mounting. Minimum letter height shall be 3/8 inch. Lettering and Background colors as indicated below:
 - a. Power Circuits:
 - 1) Normal: Verify with Owner][White lettering on Black background].
 - 2) Emergency Legally Required Standby or Essential Electrical System prior to ATS Verify with Owner][Black lettering on Orange background].
 - 3) Emergency Optional Standby: Verify with Owner][White lettering on Blue background].
 - 4) Life Safety Branch: Verify with Owner][Black Lettering on Red background].
 - 5) Equipment Emergency System: Verify with Owner][Yellow lettering on Blue background].
 - 6) Non-Essential Emergency System: Verify with Owner][White lettering on Purple background].
 - 7) UPS: Verify with Owner][White lettering on Green background].
 - b. Fire Alarm System: White lettering on Red background.
 - c. Fire-Suppression Supervisory and Control System Verify with Owner][Yellow lettering on Red background].
 - d. Mechanical and Electrical Supervisory System: Verify with Owner][Green lettering on Blue background].
 - e. Control Wiring: Verify with Owner][Green lettering on Red background].

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Conductor Color-Coding Key: Engraved, Laminated Acrylic, Melamine Label, or Decal-Style Label: Adhesive, Punched, or drilled for screw mounting. Minimum letter height shall be 3/8 inch. Key to describe the conductor color coding scheme used in building in accordance with NFPA 70.

2.10 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.
- D. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.
1. Exterior Ferrous Metal:
 - a. Semigloss Alkyd-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Exterior ferrous-metal primer.
 - 2) Finish Coats: Exterior semigloss alkyd enamel.
 2. Exterior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Alkyd-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Exterior zinc-coated metal primer.
 - 2) Finish Coats: Exterior semigloss alkyd enamel.
 3. Interior Ferrous Metal:
 - a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
 4. Interior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- E. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- H. Conductor Color-Coding Key: Install Instructional Label denoting the conductor color-coding scheme on all panelboards, distribution boards, switchboards, switchgear, motor-control center and similar equipment.
- I. Conductor Color-Coding for Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied to conductors or for sizes larger than No. 8 AWG, if authorities having jurisdiction permit, field applied.
 - 2. Colors for Grounding Conductors:
 - a. Equipment Grounding Conductor: Green.
 - b. Isolated Equipment Grounding Conductor: Green with Yellow Stripe.
 - 3. Colors for 208/120-V Wye Systems:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Grounded Conductor (Neutral): White
 - 4. Colors for 208/120-V and 240/120-V Delta Systems:
 - a. Phase A: Black.
 - b. Phase B (High Leg): Orange.
 - c. Phase C: Blue.
 - d. Grounded Conductor (Neutral): White
 - 5. Colors for 480/277-V Wye Systems:
 - a. Phase A: Brown.
 - b. Phase B: [Purple or Orange]. (Verify in the field)
 - c. Phase C: Yellow.
 - d. Grounded Conductor (Neutral): Gray
 - 6. Colors for 480/277-V Delta Systems:
 - a. Phase A: Brown.
 - b. Phase B (High Leg): Orange.
 - c. Phase C: Yellow.
 - d. Grounded Conductor (Neutral): Gray
 - 7. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- J. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- K. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.
- L. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade.

Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

- M. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot maximum intervals.
- B. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands every 10 lineal feet:
 - 1. Fire Alarm System: Red.
 - 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 - 3. Combined Fire Alarm and Security System: Red and blue.
 - 4. Security System: Blue and yellow.
 - 5. Mechanical and Electrical Supervisory System: Green and blue.
 - 6. Telecommunication System: Green and yellow.
 - 7. Control Wiring: Green and red.
- D. Power-Circuit Conductor Identification, 600V or Less: Identify source and circuit number of each ungrounded conductor or set of conductors. For single conductor cables, identify phase in addition to the above.
 - 1. For conductors in pull and junction boxes, device boxes, and within 6-inches (153 mm) of termination use pre-printed marker tape.
 - 2. For conductors in vaults, manholes, hand holes and pull and junction boxes located in damp or wet locations use brass or stainless steel wraparound marker labels.
- E. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.
- F. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source and circuit number.
- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Main-Tie-Main Switchboards
 - c. Generator Paralleling Switchgear.
 - d. Controls with external control power connections.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
 3. Arc Flash Warning Labels: Apply label to door or cover at all access point of equipment including, but not limited to, the following:
 - a. Disconnect switches.
 - b. Electrical substations.
 - c. Electrical switchgear and switchboards.
 - d. Emergency system boxes and enclosures.
 - e. Enclosed circuit breakers.
 - f. Meter Sockets and assemblies.
 - g. Motor starters.
 - h. Motor-control centers.
 - i. Panelboards.
 - j. Power transfer equipment.(ATS)
 - k. Transformers.
 - l. Uninterruptible power supply equipment.

Available Fault Current Field Marking: Apply label to cover service equipment enclosure with the date in which the fault current was calculated and the available fault current as indicated on the drawings and verified by the OCPD coordination study. Table 1 below lists a typical example of label format, coordinate project specific requirements with Drawings.

Table 1 (Example Only)

MAX. AVAILABLE FAULT: XX,XXXA DATE: X/X/XX

- J. Junction Boxes and Pull Boxes: Identify voltage, source, and circuit number(s) on cover of pull and junction boxes with hand-written legible block lettering using black permanent marking pen.
- K. [Color Coding of Junction Boxes and Pull Boxes: Identify system on cover of pull and junction boxes using colored enamel spray paint. Where two colors are indicated identify each half of box with colors indicated.
 1. Power Circuits:
 - a. Normal Black.
 - b. Emergency Legally Required Standby or Essential Electrical System prior to ATS:[Verify with Owner][Black and Orange].
 - c. Emergency Optional Standby[Verify with Owner][Blue].
 - d. Life Safety Branch: Verify with Owner][Black and Red].
 - e. Critical Branch: Verify with Owner][Black and Yellow].
 - f. Equipment Emergency System: Verify with Owner][Yellow and Blue].
 - g. Non-Essential Emergency System: Verify with Owner][Purple].
 - h. UPS: Verify with Owner][Green].

2. Fire Alarm System Red.
 3. Fire-Suppression Supervisory and Control System: Verify with Owner][Red and yellow].
 4. Mechanical and Electrical Supervisory System: Verify with Owner][Green and blue].
 5. Control Wiring: Verify with Owner][Green and red].
- L. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer, load shedding, Key Interlocked Breakers etc.
- M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where 3 lines of text or more are required, use label height as required to accommodate 3/8-inch-high letters.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label drilled and attached with corrosion-resistant screws.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor per ANSI A13.1.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Distribution Equipment with Overcurrent Protective Devices to be labeled:
 - a. Provide for each of the following and any other similar equipment furnished under this Division identification as to its given name, voltage, origination of service, branch, and amps rated interrupting. Table 2 below lists typical examples of label format, coordinate project specific requirements with Drawings:
 - 1) Electrical switchboards.
 - 2) Panelboards.
 - 3) Enclosed switches.
 - 4) Enclosed circuit breakers.

Table 2 (Examples Only)

EMERGENCY SYSTEM 'EMSA' 480Y/277V FED FROM 'GEN-1' RATED INTERRUPTING: XX,XXXX	NORMAL '1DPHA' 480Y/277V FED FROM 'MSA' RATED INTERRUPTING: XX,XXXX	LIFE SAFETY BRANCH '1LSHA' 480Y/277V FED FROM 'DPLSHA' RATED INTERRUPTING: XX,XXXX
EQUIPMENT SYSTEM '1EQLA' 208Y/120V FED FROM 'T1EQLA' RATED INTERRUPTING: XX,XXXX	CRITICAL BRANCH '1CRHA' 480Y/277V FED FROM 'ATS-CR' RATED INTERRUPTING: XX,XXXX	NON-ESSENTIAL '1DPCH-N' 480Y/277V FED FROM 'ATS-N' RATED INTERRUPTING: XX,XXXX
NORMAL	NORMAL	EQUIPMENT SYSTEM

'CHP-1' 480Y/277V FED FROM 'MCC-1' RATED INTERRUPTING: XX,XXXA	'AHU-1' 480Y/277V FED FROM '1DPHA' RATED INTERRUPTING: XX,XXXA	'HWP-1' 480Y/277V FED FROM 'CPEQHA' RATED INTERRUPTING: XX,XXXA
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3. Distribution Equipment without Overcurrent Protective Devices to be labeled:
 - a. Provide for each of the following and any other similar equipment furnished under this Division identification as to its given name, voltage, origination of service, and branch. Table 3 below lists typical examples of label format, coordinate project specific requirements with Drawings:
 - 1) Electrical cabinets, and enclosures.
 - 2) Enclosed Bus Assemblies.
 - 3) Transformers: Label that includes tag designation for the transformer, feed, and panelboards or equipment supplied by the secondary.
 - 4) Disconnect switches.
 - 5) Emergency system boxes and enclosures.
 - 6) Enclosed controllers.
 - 7) Variable-speed controllers.
 - 8) Push-button stations.
 - 9) Power transfer equipment (ATS) – Label both sources.
 - 10) Auxiliary Equipment (SPD, Capacitor Banks, etc.).
 - 11) Contactors.
 - 12) Fire-alarm control panel and annunciators.
 - 13) Uninterruptible power supply equipment.

Table 3 (Examples Only)

CRITICAL BRANCH 'T2CLA' 75 KVA, 480V to 208Y/120V FED FROM '2CHA' FEEDS '2CRLA'	EQUIPMENT SYSTEM 'ATS EQ' 480Y/277V FED FROM 'MSA' NORMAL FED FROM 'EMSA' EMERGENCY FEEDS '1EQHA'	OPTIONAL STANDBY SYSTEM 'ATS SS' 480Y/277V FED FROM 'MSA' NORMAL FED FROM 'EMSA' EMERGENCY FEEDS '1SSHA'
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4. Provide for each feeder overcurrent protective device in each switchgear, switchboard, distribution panelboard, motor control center, and any other similar equipment furnished under this Division, identification as to the specific load that it serves.
5. Provide for each 3 phase motor: brass phase rotation tags securely attached to the equipment.

END OF SECTION

SECTION 260573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for computer-based, fault-current and overcurrent protective device coordination studies and arc flash protection study. Protective devices shall be set based on Engineer's review of submitted results of the protective device coordination study.
 - 1. Coordination of series-rated devices is permitted where indicated on Drawings.
 - 2. Coordination of series-rated devices is not permitted.
 - 3. Delegated Design Requirements for Arc Flash Hazard Analysis.

1.2 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds.
- B. Delegated Design for Arc Flash Hazard Analysis: Prepare computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Simultaneous Action Submittals: The following action submittals shall be made in conjunction with the approval process for system protective devices specified in other

Division 26 Sections. The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner. The following submittals shall be in digital form:

1. Coordination-study input data, including completed computer program input data sheets. Provide editable electronic media including all SKM files and breaker TCC's.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report; signed, dated, and sealed by a qualified professional engineer.
4. Arc-flash study input data, including completed computer program input data sheets.
5. Arc Flash Hazard Analysis Report; signed, dated, and sealed by a qualified professional engineer.

C. Product Data: For computer software program to be used for studies.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Specialist and Arc-Flash Hazard Analysis Specialist.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399. For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
- a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - 4) Coordination setting schedules.
 - b. Power system data.
- B. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- C. Operation and Maintenance Procedures: In addition to items specified in Division 01 Section "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Delegated Design System Study Specialist Qualifications: Comprehensive engineering analysis by a qualified Professional Engineer or personnel trained and employed by the equipment manufacturer in required calculation methodology.
 - 1. Analysis to be performed by a Professional Engineer or personnel trained, employed, and supervised by a registered Professional Engineer.
 - 2. Registered professional engineer shall be a full-time employee of the electrical equipment manufacturer or a professional engineering firm.
 - 3. Report shall be signed and sealed by a Professional Engineer with current registration in the state of Texas.
- D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- E. Comply with IEEE 399 for general study procedures.
- F. Comply with IEEE 1584 for performing Arc Flash Hazard Calculations.

PART 2 - PRODUCTS

2.1 OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: The overcurrent protective device (OCPD) types indicated on the Drawings correspond to products produced by Square D; Schneider Electric. Subject to compliance with the requirements, produce Overcurrent Protective Device Coordination Study based on the exact equipment proposed for inclusion in the Work by the basis-of-design manufacturer, or a comparable product by one of the following acceptable manufacturers listed below.
 - 1. Cutler-Hammer, Inc.; Eaton Corporation.
 - 2. General Electric Co.; Electrical Distribution & Protection Div.
 - 3. Siemens Energy & Automation, Inc.

2.2 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc.

2.3 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 242 and IEEE 399 for fault-current and overcurrent protective device coordination studies.

- B. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard analysis.
- C. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate coordination by computer-generated, time-current coordination plots.

2.4 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive Summary
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- E. Short-Circuit Study Output:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.5 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
 - E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article above.
 - F. Protective Device Coordination Study:
 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
 - G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
5. ~~[Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating]~~

~~of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.]~~

6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

2.6 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope.
- C. One-line diagram, showing the following:
 1. Protective device designations and ampere ratings.
 2. Cable size and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article above.
- F. Arc-Flash Study Output:
 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- G. Incident Energy and Flash Protection Boundary Calculations:
 1. Arcing fault magnitude.
 2. Protective device clearing time.
 3. Duration of arc.
 4. Arc-flash boundary.
 5. Working distance.
 6. Incident energy.
 7. Hazard risk category.
 8. Recommendations for arc-flash energy reduction.
- H. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

- I. Equipment specific Arc Flash Warning Labels.

2.7 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Flash Hazard Boundary
 - 2. Short Circuit Current Available
 - 3. Shock Hazard when Cover is Removed
 - 4. Limited Approach Boundary
 - 5. Restricted Approach Boundary
 - 6. Prohibited Approach Boundary
 - 7. PPE Requirements, including the following:
 - a. Hazard Risk Category
 - b. Required Minimum Arc Rating of PPE in cal/cm²
 - c. Clothing Description
 - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.]

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
 - 1. Proceed with coordination study and arc-flash study only after relevant equipment submittals have been assembled, but prior to their submission to the Architect.
 - a. Coordination study shall accompany submission of relevant equipment submittals.
 - b. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Delegated Design System Analyst performing the short-circuit, protective device coordination study, and arc flash hazard analysis shall furnish the Contractor with a list of required data immediately after award of the contract. Contractor shall expedite collection of the data to ensure completion of the study and analysis as required.
- B. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
- C. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
 - 1. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field.

2. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
- D. Source combination shall include present and future motors and generators indicated in the documents.
- E. If applicable, include fault contribution of existing motors in the study and analysis.
- F. Gather and tabulate the following input data to support coordination study:
1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Service entrance- Fault duty of the electric utility at the primary point at which the new facility receives its primary service.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit breakers and fuses ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, X/R ratios, taps measured in per cent, and phase shift.
 - d. Generator short-circuit current contribution data, including short-circuit reactance, rated kilovolt amperes, size, rated voltage, and X/R ratio.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity, impedance, lengths, and conductor material.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - h. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 - i. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. A short-circuit current ratings indicated in the Contract Documents are based on Fault-Current study prepared by the Engineer during design and are based on available information and anticipated feeder lengths. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system based on proposed feeder routing. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Electric Utility's supply termination point.
 - 1. Service Entrance Equipment. Switchgear and switchboard bus.
 - 2. Unit substation primary and secondary terminals.
 - 3. Medium-voltage controller.
 - 4. Motor-control center.
 - 5. Distribution panelboard.
 - 6. Branch circuit panelboard.
 - 7. Standby Generators and Transfer Switches.
 - 8. Enclosed Fused Switch.
 - 9. Enclosed Circuit Breaker.
 - 10. Enclosed Bus Assembly.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculate short-circuit currents according to IEEE 551.
- E. In addition to IEEE 551 short-circuit current calculations, calculate the short-circuit currents at the following:
 - 1. Motor Controllers: Rated greater than or equal to 2hp at 300V or more.
 - 2. Air-Conditioning and Refrigerating Equipment Controllers: Including, but not limited to, equipment supplied from a branch circuit protected at greater than 60A.
 - 3. Industrial Control Panels.
 - 4. Elevator Controllers.
- F. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 - 1. Transformers, as appropriate for transformers included in the Work:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. Low-Voltage Fuses: IEEE C37.46.
- G. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram, including existing Service Entrance equipment.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

H. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Ensure that short-circuit withstand ratings are equal to or higher than the calculated 1/2-cycle symmetrical fault current for the following:
 - a. Electrical Distribution Equipment: Including, but not limited to, switchgear, switchboards, and panel boards.
 - b. Motor Controllers.
 - c. Air-Conditioning and Refrigerating Equipment Controllers.
 - d. Industrial Control Panels.
 - e. Elevator Controllers.
4. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
5. Notify Engineer, in writing, of any existing circuit protective devices improperly rated for the calculated available fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate on log-log scale graphs, with no more than five devices indicated on any plot that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Electric Utility's overcurrent protective device.
 - b. Medium voltage equipment overcurrent relays.
 - c. Device tag.
 - d. Voltage and current ratio for curves.
 - e. Three-phase and single-phase damage points for each transformer.
 - f. No damage, melting, and clearing curves for fuses.
 - g. Cable damage curves.
 - h. Transformer inrush points.
 - i. Maximum fault-current cutoff point.
 - j. Motor starting characteristics, damage points and overload relay.
 - k. Thermal damage curve for motors larger than 100 HP.
 - l. Generator short-circuit decrement curve and damage point, and thermal damage curve.
- F. Completed data sheets for setting of overcurrent protective devices.
- G. Complete Schedule of breaker settings to summarize information contained on data sheets. Sample schedule has been included at the end of this section for preferred format.

3.5 ARC FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system where work could be performed on energized parts including, but not limited to, the following:
1. Disconnect switches.
 2. Electrical substations.
 3. Electrical switchgear and switchboards.
 4. Emergency system boxes and enclosures.
 5. Enclosed circuit breakers.
 6. Meter Sockets and assemblies.
 7. Motor starter.
 8. Motor-control centers.
 9. Panelboards.
 10. Power transfer equipment. (ATS)
 11. Transformers.

12. Uninterruptible power supply equipment.

- C. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent protection relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
 - D. Calculate the arc-flash protection boundary and the corresponding incident energy calculations for multiple system scenarios to be compared and the greatest incident energy to be uniquely reported for each equipment location. Calculations to be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions.
 - 1. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off).
 - 2. The maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
 - E. Incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators to be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible.
 - F. For each equipment location with a separately enclosed main device, calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
 - 1. When performing incident energy calculations on the line side of a main breaker, the line side and load side contributions must be included in the fault calculation.
 - G. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device to compute the incident energy for the corresponding location.
 - H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash even, a maximum clearing time based on the specific location shall be utilized.
 - I. Complete Arc Flash report to be used for the preparation of Arc Flash Warning labels for electrical equipment. Refer to Division 26 Section "Identification for Electrical Systems" for requirements of Arc Flash Study and labels.]
- 3.6 Correct Deficiencies, Re-calculate and Report:
- A. After Engineer's initial review, correct unsatisfactory conditions and recalculate to demonstrate compliance; resubmit overcurrent protective devices as required to bring system into compliance.

- B. Revise and Resubmit report multiple times as necessary to demonstrate compliance with requirements.

3.7 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels as specified in Division 26 Section "Identification for Electrical Systems". Install labels under the direct supervision and control of the Arc-Flash Hazard Study Specialist.

3.8 DEMONSTRATION

- A. Engage the Arc-Flash Hazard Study Specialist or a qualified manufacturer's representative to train Owner's management and maintenance personnel of the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels, minimum of four (4) hours. Refer to Division 01 Section "Demonstration and Training."
 - 1. Training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.
 - 2. Include in Project Close-out Documents training notes, outlines, Power Point presentation of training session, and DVD of recorded training session. Also include attendance record of personnel attending the training session.

END OF SECTION

[illegible]

OVERCURRENT PROTECTIVE
DEVICE COORDINATION STUDY
100% Construction Documents
September 1, 2017 (REVISED 9-27-17)

SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following categories of lighting control devices:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Standalone daylight-harvesting switching controls.
 - 4. Indoor occupancy sensors.
 - 5. Lighting contactors.
 - 6. Emergency shunt relays.
 - 7. Within each category are various models and technologies available for use shall be selected based on the application indicated on the drawing.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers, manual light switches, and timer wall-switches.
 - 2. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.

1.2 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: These specifications and the accompanying Drawings define the intent of the lighting control system to be provided. The switches, sensors, control stations and switching group designations shown on the Drawings define how lighting should be grouped for control. Provide the necessary quantity and type of distributed control products necessary to achieve the design intent. In addition to the system as specified herein and shown on the Drawings, provide all planning, design, calculations, equipment, devices, cabling, system programming and any other component or service required for a complete, fully operational and code compliant system.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For control modules, power distribution components, control network materials, manual switches and plates, and conductors and cables.
- C. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

- D. Delegated-Design Shop Drawings: Prepared by factory or authorized representative; based on devices proposed for inclusion in the Work. Include detail assemblies of standard components, custom assembled for specific application on this Project.
 - 1. Floor Plans: showing all control stations, control devices, input devices, cabling, power sources, and other necessary equipment and components.
 - 2. Control Station Legend: annotated to describe which stations shown in the Product Data are places at keyed locations.
 - 3. Scene Schedules: schedule for each unique room type with scene descriptions.
 - 4. System Riser: showing all components with their location labeled.
 - 5. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 6. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 7. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
 - 8. Interconnection diagrams showing field-installed wiring.
 - 9. Dimensioned locations of occupancy and light-level sensors.
 - 10. Coverage patterns for occupancy and light-level sensors.
 - 11. Include diagrams for power, signal, and control wiring.
- E. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section "Common Work Results for Electrical".
- F. Product Certificates: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting control device, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for adjusting devices after installation.

1.7 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including but not limited to luminaires, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Invensys Controls.
 4. Leviton Manufacturing Co., Inc.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. NSi Industries LLC; TORK Products.
 7. Square D.
 8. Tyco Electronics.
 9. Watt Stopper.
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Contact Configuration: SPST, DPST, or DPDT, as indicated.
 3. Contact Rating: 20-A ballast load, 120/277-V ac, and minimum of 30,000 switching cycles.
 4. Programs: number of channels as indicated on Drawings; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays; unless otherwise indicated.
 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
 6. Astronomic Time: For Selected channels.
 7. Automatic daylight savings time changeover.
 8. Battery Backup and non-volatile memory for schedules and time clock, meeting the requirements of ASHRAE 90.1.

2.2 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Eaton Corporation
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lithonia Lighting; Acuity Brands Lighting, Inc.
 6. Lutron Electronics Co., Inc.
 7. NSi Industries LLC; TORK Products.
 8. Sensor Switch, Inc.
 9. Tyco Electronics.
 10. Watt Stopper.
- B. Ceiling-Mounted or Switching Controls: Solid-state, light-level sensor unit, with separate power pack mounted on luminaire as appropriate, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
4. Power Pack: Dry contacts rated for [20]-A ballast load at 120- and 277-V ac, ~~for [13]-A tungsten at 120-V ac~~, and for [1]hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
11. Control Load Status: User selectable to confirm that load wiring is correct.
12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Leviton Manufacturing Co., Inc.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. Lutron Electronics Co., Inc.
 6. Watt Stopper.
- B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
 3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.4 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bryant Electric.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Brands Lighting, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D.
 12. Watt Stopper.
- B. General Requirements for Sensors: Wall- or ceiling-mounting, solid-state indoor occupancy sensors with a power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the power pack.
 3. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V ac/dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: Digital display, to show when motion is being detected during testing and normal operation of the sensor.
 6. Detector Coverage: Occupancy sensor system shall cover the entire room or space served. Manufacturer selected for inclusion in the Work shall produce Delegated Design Shop Drawings with device layout and adjust sensor types or quantities as required by their specific products to provide complete coverage. Additional costs will not be considered for adjustments or device additions to meet performance requirements.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounting; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
- D. Ultrasonic Type: Ceiling mounting; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Comply with NEMA Standard LC 1-2007 "Test Procedures for Compatibility of Hearing Aids and Ultrasonic Lighting Control Devices".
 2. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

- E. Dual-Technology Type: Ceiling mounting; detect occupants in coverage area using PIR and ultra-sonic detection methods. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Comply with NEMA Standard LC 1-2007 "Test Procedures for Compatibility of Hearing Aids and Ultrasonic Lighting Control Devices".
 2. Sensitivity Adjustment: Separate for each sensing technology.
 3. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
- F. Operation:
1. Occupancy Mode – Auto On/Off, with Manual On/Off: Turn lights on when covered area is occupied and then off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 5 to 30 minutes. Depressing manual switch will override current state.
 - a. Manual override: Momentary contact low-voltage switch.
 2. Vacancy Mode - Manual On/Off Auto Off: Turn lights on/off when manual switch is depressed. When covered area is unoccupied, turn lights off automatically; with a time delay, adjustable over a minimum range of 5 to 30 minutes.
 - a. Manual override: Momentary contact low-voltage switch.
 3. Bi-Level Occupancy Mode - Bi-Level, Auto On/Off, Manual On/Off: Turn not more than 50% lights on when covered area is occupied. Turn remaining lights on with manual switch #2 is depressed. When covered area is unoccupied turn 100% lights off automatically; with a time delay, adjustable over a minimum range of 5 to 30 minutes. Depressing manual switch #1 or #2 will override current state for respective loads.
 - a. Manual override: Momentary contact low-voltage switch.
 4. Bi-Level Vacancy Mode - Bi-Level, Manual On/Off, Auto Off: Turn not more than 50% lights on/off when manual switch #1 is depressed. Turn remaining lights on/off with manual switch #2 is depressed. When covered area is unoccupied, turn 100% lights off automatically, with a time delay, adjustable over a minimum range of 5 to 30 minutes.
 - a. Manual override: Momentary contact low-voltage switch.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Bryant Electric.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Manufacturing Co., Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Brands Lighting, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D.
 12. Watt Stopper.

- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 4. Connectors shall comply with UL 2459.
 5. Devices shall comply with the requirements in this Section.
- C. Wall-Switch Sensor:
1. Comply with NEMA Standard LC 1-2007 "Test Procedures for Compatibility of Hearing Aids and Ultrasonic Lighting Control Devices".
 2. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area as required by application.
 3. Sensing Technology: Dual technology - PIR and ultrasonic.
 4. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off." Single circuit and dual circuit as required by Drawings.
 5. Voltage: Match the circuit voltage.
 6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- D. Finishes, including device color, wall plate and lettering: Comply with Division 26 Section "Wiring Devices."
- E. Wall Plates: Comply with wall plate requirements in Division 26 Section "Wiring Devices."

2.6 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 3. Eaton Corporation.
 4. General Electric Company.
 5. Square D.
- B. Description: Electrically operated and [mechanically held combination type with nonfused disconnect, unless otherwise indicated.] Standard coil clearing contacts are to be provided so that the contactor coils shall be normally [closed] as appropriate for the application [opened] unless otherwise indicated. Contactor to comply with NEMA ICS 2 "Industrial Control Devices, Controllers, and Assemblies", UL 508 "Standard for Industrial Control Equipment", NEMA ICS 6 "Enclosures for Industrial Controls and Systems" and NFPA 70 "National Electrical Code".
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Contacts: Totally enclosed, double-break silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring. All contacts shall have clearly visible N.O. and N.C. contact status indicators.
 3. Poles: As indicated on drawings.

4. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 5. Enclosure: Comply with NEMA 250 and ANSI/NEMA ICS 6, Type 1 or 3R, as required to meet conditions of installation.
 6. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
 7. Wiring: Straight-through wiring with all terminals clearly marked.
 8. Accessories:
 - a. Selector Switch: HAND-OFF-AUTOMATIC
 - b. Auxiliary Contacts: Two, normally open and normally closed, field convertible.
- C. Interface with FMS System: Provide hardware interface to enable the FMS to monitor and control lighting contactors.
1. Monitoring: On-off status.
 2. Control: On-off operation.
- 2.7 EMERGENCY SHUNT RELAY
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lighting Control and Design.
 2. Watt Stopper.
- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contact as indicated; complying with UL 924.
1. Coil Rating: 120-V or 277-V, as indicated.
- 2.8 CONDUCTORS AND CABLES
- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG or larger if otherwise required by manufacturer. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG or larger if otherwise required by manufacturer. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

- C. Switchbox-mounted sensors:
 - 1. Set field selectable sensors to manual "on" automatic "off" for all devices indicated to be Vacancy sensors on the Drawings. Set all other sensors to field selectable automatic "on".
 - 2. Comply with installation and connection requirements in Division 26 Section "Wiring Devices."

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.
- B. Install in accordance with manufacturer's instructions.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.
- C. Switchbox-mounted sensors: Comply with identification requirements in Division 26 Section "Wiring Devices."

3.5 FIELD QUALITY CONTROL

- A. [Perform the following field tests and inspections with the assistance of a factory-authorized service representative and prepare test reports:]
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Time-Schedule Adjustments: Times indicated in documents represent initial settings known at time of design documentation. Coordinate final program settings for time-of-day and holiday schedules with Owner prior to Substantial Completion. When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjust schedules to suit Owner. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. Reset all adaptive technology and learning devices post-construction.
 - 2. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 3. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.7 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. On completion of device box installation but before any wiring devices are installed, inspect interior of boxes and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of wall plate installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Replace cracked or damaged wall plates.
 - 3. Wipe down all wall plates with approve cleaning agent to remove fingerprints and dust.

3.8 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 260943

NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes manually operable, PC-based, digital lighting controls with external signal source, relays, electrically operated circuit breakers, and control module.
- B. Building lighting control system can communicate with other building systems via bacnet ip communication protocol.
- C. The basis of design for the lighting control system is an nLIGHT digital network lighting control system. The system will automatic on/off control via time schedule for corridors, waiting rooms & elevator lobby during non-visitor hours and back to 100% based on time schedule with lighting override/scene selector control located at each reception and staff work station (refer to control schedule for more information). Provide system with all cat-5e cabling between devices per manufacturer recommendations.
- D. Back of house area will be controlled with stand alone occupancy sensors.

1.2 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BIM: Building information modeling.
- C. DALI: Digital addressable lighting interface.
- D. FMS: Facility management system.
- E. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- G. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- H. PC: Personal computer; sometimes plural as "PCs."
- I. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- J. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.
- K. UTP: Unshielded twisted pair.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, manual switches and plates, and conductors and cables.
- C. Shop Drawings: Prepared by factory or authorized representative; based on devices proposed for inclusion in the Work. Include detail assemblies of standard components, custom assembled for specific application on this Project.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 4. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- B. Product Certificates: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- C. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- D. Field quality-control test reports.

- E. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- F. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting controls, to include in emergency, operation, and maintenance manuals. Provide items specified in Division 01 Section "Operation and Maintenance Data."

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 and marked for intended use.
- C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.
 - 2. Coordinate lighting controls with [FMS] or [HVAC controls] as appropriate. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
 - 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.
- B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 - 2. Warranty Period: Two years from date of Substantial Completion.
 - 3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
 - 4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

1.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.
 - 1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acuity Brands Lighting, Inc.
 - 2. Intelligent Lighting Controls.
 - 3. Leviton Mfg. Company Inc.
 - 4. Lighting Control & Design, Inc.
 - 5. Lightolier Controls; a Genlyte Company.
 - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 7. Lutron Electronics Company, Inc.
 - 8. Musco Lighting.
 - 9. NexLight; part of Northport Engineering Group.
 - 10. Square D; Schneider Electric.
 - 11. Touch-Plate, Inc.
 - 12. Triatek, Inc.
 - 13. Watt Stopper.

2.2 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switches, an internal timing and control unit, and external sensors or other control signal sources send a signal to a PC-based network system control signal sources send a signal to a PC-based programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays, electrically operated circuit breakers in the power-supply circuits, or routes variable commands to one or more dimmers, for groups of lighting fixtures or other loads.
- C. FMS Interface: Provide hardware and software to enable the FMS to monitor, control, display, and record data for use in processing reports.
 - 1. Hardwired Points:
 - a. Monitoring: On-off status, <Insert monitoring point>.
 - b. Control: On-off operation, <Insert control point>.
 - 2. [ASHRAE 135 (BACnet)] [LonTalk] [Modbus] [Industry-accepted, open-protocol], compatible with existing campus <Insert type of interface> communication interface with the FMS shall enable the FMS operator to remotely control and monitor lighting

from a FMS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the FMS.

2.3 CONTROL MODULE

- A. The network control module scheme shall use the most appropriate of the following based on the network lighting control diagram indicated on the drawings. Vendors shall propose a base module sufficient to satisfy the requirements indicated on the drawings and an alternate module clearly defined the alternate proposal.
- B. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.
- C. [Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Unit shall be networked for control of indicated number of output circuits. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices, all located in other enclosures. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD shall display manual-control and programming steps. Modules and their associated control panels shall include the following features:
1. [Multichannel output with ~~<Insert number>~~ number of channels defined by the drawing.]
 2. [Multiple inputs and multichannel output arranged for ~~<Insert number>~~ number of channels defined by the drawing.]
 3. [Multiple inputs for indicated occupancy sensors and hand-held programming device.]]
- D. [Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Control units shall be networked and capable of receiving inputs from indicated sensors and hand-held programmer. Output circuits shall be pilot-duty relays compatible with power switching devices. Output circuits shall include digital circuits arranged to transmit control commands to remote preset dimmers. Modules and their associated control panels shall include the following features:
1. [Multichannel output with ~~<Insert number>~~ number of channels defined by the drawing.]
 2. [Multiple inputs and multichannel output arranged for ~~<Insert number>~~ number of channels defined by the drawing.]
 3. [Multiple inputs for occupancy sensors, daylight sensors, and dimming systems with associated daylight sensors.]]
- E. [Control Module Description: Panelboard mounted; comply with UL 916 (CSA C22.2, No. 205); microprocessor based, solid-state, 365-day timing and control unit. Control units shall be networked and capable of receiving inputs from sensors and other sources. Panelboard shall use low-voltage-controlled, electrically operated, molded-case branch circuit breakers as prime power-circuit switching devices. Circuit breakers and a limited number of digital or analog, low-voltage control-circuit outputs shall be individually

controlled by control module. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable. Panelboard shall also comply with Division 26 Section "Panelboards."

- F. [Control Module Description: Comply with UL 508 (CSA C22.2, No. 14); microprocessor-based, networked, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.]

2.4 POWER DISTRIBUTION COMPONENTS

- A. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
1. Cabinet: Steel with hinged, locking door.
 - a. Barriers separate low-voltage and line-voltage components.
 - b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
 - c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
 2. Single-Pole Relays: Mechanically held, unless otherwise indicated; split-coil, momentary-pulsed type.
 - a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
 - b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
 - c. Endurance: 50,000 cycles at rated capacity.
 - d. Mounting: Provision for easy removal and installation in relay cabinet.
- B. Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Comply with NEMA PB 1 and UL 50 (CSA C22.2, No. 94), UL 67 (CSA C22.2, No. 29), UL 489 (CSA C22.2, No. 65), and UL 916 (CSA C22.2, No. 205).
1. Cabinets: In addition to requirements specified below, comply with Division 26 Section "Panelboards."
 2. Electrically Operated, Molded-Case Circuit Breakers: Bolt-on type.
 - a. Switching Endurance Ratings: Certified by manufacturer or by a nationally recognized testing laboratory (NRTL) for at least 20,000 open and close operations under rated load at 0.8 power factor.
 - b. Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent tungsten filament load.
 - c. Minimum 30,000 open and close operations with load equal to circuit-breaker trip rating and consisting of 100 percent fluorescent ballasts rated for 10 percent total harmonic distortion.
 - d. Listed and labeled as complying with UL SWD, HCAR, and HID ratings by a national recognized testing laboratory (NRTL) acceptable to authorities having jurisdiction.
- C. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.5 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
 - 1. Match color specified in Division 26 Section "Wiring Devices."
 - 2. [Integral green [LED] pilot light to indicate when circuit is on.]
 - 3. [Internal white [LED] locator light to illuminate when circuit is off.]
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."
- C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."
- D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."
- E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

2.6 FIELD-MOUNTED DIGITAL CONTROLS AND PLATES

- A. Connection Type: RS-485 protocol, category [5] or [5e] as required UTP cable, using RJ45 connectors. Power shall be from the control unit.
- B. Pushbutton Switches: Modular, solid-state, programmable, digital, momentary contact, designed to connect to a microprocessor based control unit as a manual control source.
 - 1. Mounting: Standard single-gang recessed switchbox, using device plates specified in Division 26 Section "Wiring Devices."
 - 2. Multi-Gang Mounting: One to six pushbuttons per gang.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. [18] AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Stranded copper, complying with UL 83, multiconductor cable with copper conductors not smaller than No. [14] AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Structured Network Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category [5e] or [6] as appropriate for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."
- E. RS-485 Cables:
 - 1. Standard Cable: NFPA 70, Type CM[or CMG].
 - a. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. PVC insulation.
 - c. Unshielded.
 - d. PVC jacket.

- e. Flame Resistance: Comply with UL 1581.
- 2. Plenum-Rated Cable: NFPA 70, Type CMP.
 - a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. Fluorinated ethylene propylene insulation.
 - c. Unshielded.
 - d. Fluorinated ethylene propylene jacket.
 - e. Flame Resistance: NFPA 262, Flame Test.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Comply with NECA 504, "Recommended Practice for the Installing Lighting Control Devices and Systems" as published by the National Electrical Contractors Association.
- C. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions
- E. Install field-mounting surge protective devices for lighting control devices in Category A locations that do not have integral line-voltage surge protection. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
- B. Label time switches and contactors with a unique designation.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections[, and assist in field testing]. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Test for circuit continuity.
 - 2. Verify that the control module features are operational.
 - 3. Check operation of local override controls.
 - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.
- C. Lighting controls will be considered defective if they do not pass tests and inspections.

3.4 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.5 ADJUSTING

- A. Time-Schedule Adjustments: Times indicated in documents represent initial settings known at time of design documentation. Coordinate final program settings for time-of-day and holiday schedules with Owner prior to Substantial Completion. When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjust schedules to suit Owner. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.6 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. On completion of device box installation but before any wiring devices are installed, inspect interior of boxes and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of wall plate installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Replace cracked or damaged wall plates.
 - 3. Remove all temporary markings and labels.
 - 4. Wipe down all wall plates with approve cleaning agent to remove fingerprints and dust.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for devices specified in Division 26 Section "Lighting Control Devices."
- B. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. Refer to Division 01 Section "Demonstration and Training."

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SECTION 262200

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1500 kVA:
 - 1. Distribution transformers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for stacked transformers, ~~[including comprehensive engineering analysis by a qualified professional engineer,]~~ using performance requirements and design criteria indicated.
 - 1. Design equipment supports for stacked transformers capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
 - 1. Include typical manufacturer's test data reports for each type and size transformer. Reports shall include but not be limited to the following data:
 - a. Maximum Efficiency in accordance with NEMA TP 1.
 - b. Efficiency at 50-percent and 100-percent load.
 - c. Percent voltage regulation at 80-percent and 100-percent power factor.
 - d. Losses in kVA at no load and full load conditions.
 - e. Percent X and Percent R values,
 - f. Maximum sound level of transformer in enclosure (in dBA).
 - g. Maximum 30-Deg hot spot and average temperature rise over a 40 degree C ambient.
- C. Delegated-Design Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Stacked Transformers Rack: show fabrication and installation details and include calculations for equipment supports.

- D. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where transformers are included in the Work. Include the following:
 - 1. Ground rod and grounding cable locations.

1.4 ACTION SUBMITTALS

- A. **Manufacturer Seismic Qualification Certification:** certification that transformers, supporting devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Qualification Data: For testing agency.
- C. Source quality-control test reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for transformers and all installed components.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer, unless otherwise indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which

equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

- D. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- E. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. General Electric Company.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."
- E. Cores: High grade, grain-oriented, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses.
- F. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Aluminum

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.
- C. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Cores: One leg per phase.
- E. Enclosure for Interior Transformers: Ventilated, NEMA 250, Type 2, unless otherwise indicated.
1. Core and coil shall be impregnated within resin compound, sealing out moisture and air.
- F. Enclosure for Exterior Transformers: Ventilated, NEMA 250, Type 3R, unless otherwise indicated.
1. Core and coil shall be impregnated within resin compound, sealing out moisture and air.
- G. Transformer Enclosure Finish: Comply with NEMA 250. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces.
1. Finish Color: ANSI Gray.
- H. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- I. Taps for Transformers 7.5 to 14 kVA: Two 5 percent taps below normal full capacity.
- J. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- K. Insulation Class: Materials in accordance with NEMA ST20 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Construct K-rated transformers in accordance with requirements of Distribution Transformers listed above, unless otherwise indicated.
 2. Indicate value of K-factor on transformer nameplate.
 3. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
 4. Neutral Terminal: Rated for 200-percent of secondary phase current.
 5. Electrostatic Shielding: Provide electrostatic shield as specified below.]
- M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91, unless otherwise indicated.
1. 9 kVA and below: 37 dBA
 2. 10 kVA to 50 kVA: 42 dBA
 3. 51 kVA to 150 kVA: 47 dBA
 4. 151 kVA to 300 kVA: 52 dBA
 5. 301 kVA to 500 kVA: 57 dBA
 6. 501 kVA to 700 kVA: 59 dBA
 7. 701 kVA to 1000 kVA: 61 dBA

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Transformer Mounting
 - 1. 15 kVA or less: Floor mounted or suspended, as indicated.
 - 2. 30 kVA and 45kVA: floor mounted, rack mounted or suspended, as indicated.
 - 3. 75 kVA: Floor mounted or rack mounted, as indicated.
 - 4. Greater than 75 kVA: Floor mounted or rack mounted, unless otherwise indicated.

3.3 INSTALLATION

- A. Comply with NECA 409, "Recommended Practice for Installing and Maintaining Dry-Type Transformers" as published by the National Electrical Contractors Association.
- B. Install and anchor floor-mounted transformers level on concrete bases, 4-inch nominal thickness according to manufacturer's written instructions. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03. **Comply with seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."**
- C. Construct steel channel support system for rack-mounted or suspended transformers according to manufacturer's written instruction and requirements of Division 26 Section "Hangers and Supports for Electrical Systems." **Comply with seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."**
- D. Comply with vibration isolation for transformers per requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems"

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Transformer Nameplates: Label each transformer with Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

3.5 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Ground transformer before it is energized.
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Provide flexible metal conduit with a minimum 12" to a maximum 24" length for wiring connections to transformer enclosure.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2 for dry-type transformers. Certify compliance with test parameters.
 - 3. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
 - a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each transformer's connections. Remove covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- B. Correct Deficiencies and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace transformers, conductors, units, and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a report, certified by testing agency, that identifies transformer, connection, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.7 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report listing output voltages and tap settings.

3.8 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. On completion of installation, inspect interior and exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 3. Repair exposed surfaces to match original finish.

3.9 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain transformers. Refer to Division 01 Section "Demonstration and Training."

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SECTION 262413

SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.
- B. Related Sections include the following:
 - 1. ~~[Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.]~~
 - 2. Division 26 Section "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 3. Division 16 26 Section "SPD for Low-Voltage Electrical Power Circuits" for internal surge protective devices.

1.2 DEFINITIONS

- A. DPM: Multifunction Digital-Metering Monitor
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. GFEP: Ground-fault equipment protection.
- E. RFI: Radio-frequency interference.
- F. RMS: Root mean square.
- G. SCADA: Supervisory Control And Data Acquisition.
- H. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

1.4 ACTION SUBMITTALS

- A. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section "Common Work Results for Electrical".

- B. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- C. Simultaneous Action Submittals: Switchboard Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- D. Product Data: For each type of switchboard, overcurrent protection device, accessory, and related component, include the following:
1. Manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 2. Rated capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
 - a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.
 3. Hardcopy layout of each display screen in HMI and DPM.
 4. Power Monitoring Block Diagram: Show devices monitored and interconnections between components specified in this Section and devices furnished under Division 26 Section "Electrical Power Monitoring and Control". Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Illustrate coordination among related equipment and power monitoring and control.
- E. Shop Drawings: For each switchboard and related equipment, include the following:
1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Enclosure types and details.
 - c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
 - e. One-line diagram.
 - f. Horizontal and vertical bus current and voltage ratings.
 - g. Short-time and short-circuit current rating of equipment assembly.
 - h. Feeder entry locations and lug configuration.
 - i. Floor plan drawing showing locations for anchor bolts and leveling channels].
 - j. Nameplate legends.
 - k. ~~[One-Line Diagram Nameplate.]~~
 - l. ~~[Mimic-bus diagram.]~~
 - m. ~~[UL listing for series rating of installed devices.]~~

2. **Seismic Design Calculations:** Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
3. **Wiring Diagrams:** For each type of switchboard and related equipment, include the following:
 - a. Power, signal, and control wiring.
 - b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
 - c. Schematic control diagrams.
 - d. Diagrams showing connections of component devices and equipment.
 - e. Schematic diagrams showing connections to remote devices.

1.5 INFORMATIONAL SUBMITTALS

- A. **Coordination Drawings:** Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where switchboards are included in the Work.
- B. **Manufacturer Seismic Qualification Certification:** certification that electrical equipment assemblies, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. **Switchboard Directories:** For installation on Switchboard.
- D. **Source quality-control test reports.**
 1. **Reports and Product Certificates:** For switchboard, signed by product manufacturer.
- E. **Field quality-control Test Method and Procedure:** List of procedures to be used during functional and operations sequence testing. Method of Procedure should include but not be limited to the following:
 1. Tabulation of Testing Equipment and PPE required for tests.
 2. Schedule of Shutdowns required.
 3. Manufacturer's Recommended Pre-Start Checklists for the following:
 - a. Overcurrent Protection Devices
 - b. Metering and Monitoring Equipment
 4. Step-by-Step Testing Operations and Criteria for tests listed in Part 3 Paragraph "Field quality-control".
- F. **Field quality-control test reports including the following:**
 1. Test results that comply with requirements.
 2. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. **Operation and Maintenance Data:** For electrical equipment, accessories and components to be included in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Manufacturer's routine maintenance requirements for switchboard and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of relay and overcurrent protective device. Include directory listing each adjustable breaker included in the Work and their final set points.

4. Manufacturer's sample system checklists and log sheets.
5. Manufacturer's written instructions for sequence of operation.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Six spares for each type of switchboard cabinet lock.
 2. Touchup Paint: Three 0.5 pint containers of paint matching enclosure finish.
 3. Indicating Lights: one for every ten of each type and rating installed. Furnish at least one of each type.
 4. Spare Fuses for the following:
 - a. Potential Transformer Fuses: One for every ten of each type and rating installed. Furnish at least one of each type.
 - b. Control-Power Fuses: One for every ten of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- B. Source Limitations: Obtain switchboard, overcurrent protective devices, components, and accessories through one source from a single manufacturer, unless otherwise indicated.
 1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.
 2. Breaker Manufacturer for installation into existing switchboard: Manufacturer for breakers shall match the manufacturer of the existing equipment. For discontinued equipment, breaker shall be compatible and listed for installation within existing equipment.
- C. Product Options: Drawings indicate spatial allocation for switchboards, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum spatial allocation. Refer to Division 01 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C2.
- F. Comply with NFPA 70.
- G. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.
- E. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient Temperature for Circuit Breakers: Not less than 23 deg and not exceeding 104 deg F.
 - 2. Ambient Temperature for Fused Switches: Not less than minus 22 deg F and not exceeding 104 deg
 - 3. Altitude: Not exceeding 6600 feet (2000 m)

1.11 COORDINATION

- A. Coordinate layout and installation of switchboard and components with other construction that penetrates floors, ceilings or walls or are supported by them, including but not limited to conduit, piping, other electrical equipment, light fixtures, HVAC equipment, fire-suppression-system components and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer, Inc.; Eaton Corporation.
 - 2. General Electric Co.; Electrical Distribution & Protection Div.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric.

2.2 RATINGS

- A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.
- B. Nominal System Voltage: As indicated on the Drawings.

- C. Main-Bus: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.
- D. Short-Time and Short-Circuit Current: Match rating of highest-rated overcurrent protective device in switchboard assembly.
 - 1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.3 MANUFACTURED UNIT FABRICATION

- A. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Factory assembled and tested and complying with UL 891; including devices complying with UL 489.
- C. Mounting height of breakers shall be in accordance with NFPA 70 requirements. Fabrication of equipment shall take housekeeping pad dimension into account in determining height of top breaker in all sections. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for housekeeping pad specifications.
- D. Front-Connected, Front-Accessible Switchboard: Front and Rear aligned, with features as follows:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Feeder Devices: Panel-mounted
- E. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with copper feeder circuit-breaker line connections. ~~[Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections].~~
 - a. Lugs: Mechanical style one or two hole style to suit conditions, suitable for quantity and size of conductor. UL 486 B listed, dual rated and marked for use with copper- or aluminum conductors to suit project conditions.
 - 2. Ground Bus: 1/4-by-2-inch-hard-drawn copper of 98 percent conductivity, equipped with [mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 3. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 4. Neutral Disconnect Link: where switchboard is used as the Service Disconnecting means, provide bolted, uninsulated copper bus, arranged to connect neutral bus to ground bus. Provide bussed link sized in accordance with NFPA 70.
 - 5. Vertical Section Bus Size: Comply with UL 891, including allowance for spare circuit breakers and spaces for future circuit breakers. Include bus to extend the full length of vertical sections.
 - 6. Provide bus bars connections between vertical sections and compartments. Cable connections are not permitted.
 - 7. Support and Brace Buses for indicated short-circuit currents.
 - 8. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections.
 - 9. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.

10. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
 11. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
 - a. Minimum insulation temperature rating: 105 deg C.
 - b. Sprayed Insulation Thickness: 3 mils, minimum.
 - c. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
- F. Future Device Provisions: Equip compartments with unused space with mounting brackets, supports, bus connections, and necessary appurtenances at full rating of circuit-breaker compartment.
- G. Indoor Enclosure Fabrication: Steel, rated for environmental conditions at installed location.
1. Indoor Location Rating: NEMA 250, Type 1 ~~[Type 2]~~.
 2. Wet or Damp Indoor Location Rating: NEMA 250, Type 4.
 3. Finish: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.
 4. Access: Removable, Front and Side Compartment Covers secured by captive bolts for access to interior of switchboard.
 - ~~5. Fungus Proofing: Permanent fungicidal treatment for switchboard interior, including instruments and instrument transformers.~~
 - ~~6. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.~~
 - ~~a. Space Heater Control: Thermostats to maintain temperature of each section above expected dew point.~~
 - ~~b. Space Heater Power Source: Transformer, factory installed in switchboard.~~

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Series-rated devices are not permitted.
- B. Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated.
1. Main OCPD: Molded-Case Electronic Trip-Unit Circuit Breakers
 2. Feeder OCPD rated less than 250 Amps Molded-Case Electronic Trip-Unit Circuit Breakers
 3. Feeder OCPD rated 250 Amps and greater: Molded-Case Electronic Trip-Unit Circuit Breakers
- C. Molded-Case Circuit Breaker Requirements: NEMA AB 3, with interrupting capacity rating to meet available fault current.
1. Electronic trip-unit circuit breakers: Full Function, Fully Rated, RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
 - a. Long- and short-time pickup levels.
 - b. Long- and short-time time adjustments.
 - c. Instantaneous trip.
 - d. Ground-fault pickup level, time delay, and I^2t response, where indicated.
 - e. Ground-fault indication alarm, where indicated.
 - f. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection and short-time trip function.

- D. Molded-Case Circuit-Breaker Features: Standard frame sizes, trip ratings, and number of poles. Provide the following features for all included in the Work.
 - 1. Lugs: Mechanical, suitable for number, size, trip ratings, and conductor material; UL 486 B listed, dual rated and marked for use with copper- or aluminum load-side conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement mechanism.
 - 4. ~~Communication Capability: Communication module with functions and features compatible with power monitoring and control system specified [in Instrumentation paragraph below] in Division 26 Section "Electrical Power Monitoring and Control."~~
- E. Circuit-Breaker Accessories: Standard frame sizes, trip ratings, and number of poles. Provide the following accessories where indicated:
 - 1. Ground-Fault Protection: where indicated, provide integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 2. Ground-Fault Alarm Indication Only: where ground-fault is indicated on Emergency/Essential Electrical System, provide integrally mounted relay and adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator alarm. Relay shall not trip OCPD on ground-fault.
 - 3. Key Interlock Kit: To prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 4. Under-voltage Trip Devices: Adjustable time-delay and pickup voltage.
 - 5. Auxiliary Contacts: Contacts for remote trip indication and control. Provide two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 6. Shunt Trip: Set to trip at 55 percent of rated voltage.

2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
 - 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 - 2. Current Transformers: Ratios with accuracy class and burden suitable for connected relays, meters, and instruments.
- B. Power Monitoring Performance Requirement: Provide monitoring functions and appearances necessary to provide all items listed below, unless otherwise indicated:
 - 1. Main: Monitor the following for main bus and display at the Power Monitor Display:
 - a. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
 - b. Frequency.
 - c. THD, current and voltage, per phase.
 - d. Current, per phase rms, three-phase average and neutral.
 - e. Real power, per phase and three-phase total.
 - f. Reactive power, per phase and three-phase total.
 - g. Apparent power, per phase and three-phase total.
 - h. Power factor, per phase and three-phase total.
 - i. Demand current, per phase and three-phase average.
 - j. Demand real power, three-phase total.
 - k. Demand apparent power, three-phase total.
 - l. Accumulated energy (MWh and MVARh).
 - m. Phase rotation.

- n. Unbalance: Current and voltage.
 - o. Harmonic Power: Per phase, three phase.
 - p. Harmonic Magnitudes and Angles for Current and Voltages: for each phase voltage and current through [31st] harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle. Reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.
 - q. Waveform Capture:
 - 1) Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
 - 2) Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.
2. Feeder: Monitor the following for each feeder and display at the Power Monitor Display and at additional Display located on the Feeder OCPD:
- a. THD, current, per phase.
 - b. Current, per phase rms, three-phase average and neutral.
 - c. Real power, per phase and three-phase total.
 - d. Reactive power, per phase and three-phase total.
 - e. Apparent power, per phase and three-phase total.
 - f. Demand current, per phase and three-phase average.
 - g. Demand real power, three-phase total.
 - h. Demand apparent power, three-phase total.
 - ~~i. Accumulated energy (MWh and MVARh).~~
 - ~~j. Harmonic Power: Per phase, three phase.~~
 - ~~k. Harmonic Magnitudes and Angles for Current and Voltages: for each phase voltage and current through [31st] harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle. Reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.~~
 - ~~l. Waveform Capture:

 - 1) Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
 - 2) Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.~~
- C. Power Monitor Requirements: Multifunction Digital-Metering and Monitoring; Integral Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
- 1. Monitor Mounting and Display: Display and control unit flush or semiflush mounted in instrument compartment door.
 - a. Backlighted LCD to display metered data with touch-screen or touch-pad selecting device.
 - b. Display minimum of four values on one screen at same time.
 - 2. Reset: Allow reset of the following parameters at the display:
 - a. Peak demand current.
 - b. Peak demand power (kW) and peak demand apparent power (kVA).
 - c. Energy (MWh) and reactive energy (MVARh).
 - 3. Monitoring inputs for Main: Collected via Electronic-Trip Circuit Breaker trip unit located on Main OCPD

4. Monitoring inputs for Feeder: Collected via [Electronic-Trip Circuit Breaker trip unit located on each Feeder OCPD, and potential transformer located on main bus; rated to 600 V.
5. Current and Voltage Ratings:
 - a. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
 - b. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
 - c. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.
6. Accuracy:
 - a. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
 - b. Accuracy from Light to Full Rating:
 - 1) Power: Accurate to 0.25 percent of reading, plus 0.025 percent of full scale.
 - 2) Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.
 - 3) Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.
 - 4) Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.
7. Sampling:
 - a. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
 - b. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
8. Onboard Data Logging:
 - a. Store logged data, alarms, waveforms, and events in a minimum of 800 KB of onboard nonvolatile memory.
 - b. Stored Data:
 - 1) Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.
 - 2) Custom Data Logs: Three user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
 - a) Schedule interval.
 - b) Event definition.
 - c) Configured as "fill-and-hold" or "circular, first-in first-out."
 - 3) Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
 - 4) Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."
 - c. Default values for all logs shall be initially set at factory, with logging to begin on device power up.
9. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
 - a. Line-to-line voltage.
 - b. Line-to-neutral voltage.
 - c. Current per phase.
 - d. Line-to-line voltage unbalance.
 - e. Line-to-neutral voltage unbalance.

- f. Power factor.
- g. Displacement power factor.
- h. Total power.
- i. Total reactive power.
- j. Total apparent power.
- k. THD voltage L-L.
- l. THD voltage L-N.
- m. THD current.
- n. Frequency.
- 10. Alarms.
 - a. User Options:
 - 1) Define pickup, dropout, and delay.
 - 2) Assign one of four severity levels to make it easier for user to respond to the most important events first.
 - 3) Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
 - b. Alarm Events: All alarm setpoint values shall be field adjustable;
 - 1) Over/undercurrent
 - 2) Over/undervoltage
 - 3) Current imbalance
 - 4) Phase loss, current.
 - 5) Phase loss, voltage.
 - 6) Voltage imbalance
 - 7) Over kW demand.
 - 8) Phase reversal.
 - 9) Digital input off/on.
 - 10) End of incremental energy interval.
 - 11) End of demand interval.

2.6 CONTROL POWER

- A. Control Power Supply: Control power transformer supplying control circuits through secondary disconnect devices. Include the following features:
 - 1. Dry-type transformers, in separate compartments. Transformer sized to operate all components requiring control power connection. For units larger than 3 kVA, including primary and secondary fuses.
 - 2. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection. Fuses are specified in Division 26 Section "Fuses."
- B. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
 - 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
 - 2. Conductors sized according to NFPA 70 for duty required.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. ~~TCP/IP[and Modem Cards]~~: Provide TCP/IP[and modem cards] capable of connecting to owners IP network to communicate faults, alarms and send SMS messages.
- B. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

- C. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces where equipment will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
- B. Examine roughing-in of conduits to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.
- B. Comply with applicable portions of NECA 400, "Recommended Practice for the Installing and Maintaining Switchboards" as published by the National Electrical Contractors Association.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from equipment and components once unit is secured in place.
- D. Install and anchor equipment level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
- E. Install overcurrent protective devices, controllers, and instrumentation.
- F. Install filler plates in unused spaces.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- H. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Equipment Identification Nameplates: Label each switchboard assembly with engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."

- C. Feeder OCPD Labels: Label each OCPD with nameplate that indicates the device it feeds using engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."
- D. Switchboard Directory: Create a directory to indicate name/descriptions of installed circuit loads. Obtain approval before installing within clear plastic pocket on outside of switchboard assembly. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Diagram and Instructions:
 - 1. Frame and mount the following items in clear acrylic plastic holder on the front of switchboard.
 - a. Operating Instructions: Printed basic instructions for switchboard, including control and key-interlock sequences and emergency procedures where applicable.
 - b. System Power Riser Diagrams provided in accordance with Part 2 of this Section. Fold large format drawings neatly and place with instructions.
 - 2. Storage for Maintenance Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

- A. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of switchboard as recommended by manufacturer. Coordinate raceway sizes required by manufacturer and provide raceway as necessary to accommodate required wiring.
- E. Provide connection from TCP/IP card to Owner's IP network.
- F. Provide connection from terminal block to Facility Management System.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Assist in field testing of equipment including pre-testing and adjusting of equipment and components. Pre-Testing includes, but is not limited to, item provided on Manufacturers start-up check lists and NETA pre-testing requirements.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 - 2. Inspect switchboard installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.

3. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
- C. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
1. After installing switchboard but before equipment is energized, verify that grounding system at switchboard tests to specified value or better.
 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Section 7.1 for Switchgear & Switchboard Assemblies
 - b. Section 7.3 for Cables
 - c. Section 7.6 for Circuit Breakers
 - d. Section 7.10 for Instrument Transformers
 - e. Section 7.11 for Metering and Instrumentation Devices
 - f. Section 7.13 for Grounding Systems
 - g. Section 7.14 for Ground-Fault Protection Systems; where applicable.
 3. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
 - a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each switchboard. Open or remove doors and covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. The testing agency, in conjunction with manufacturer's field service: Engage a factory-authorized service representative to perform the following field tests and inspections and prepare certified test reports:
1. Complete installation and startup checks according to manufacturer's written instructions.
- E. Correct Deficiencies, Retest and Report:
1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Prepare a report, certified by testing agency, that identifies switchboards, units, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.6 ADJUSTING

- A. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.
1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Coordination Study" are completed.

3.7 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 4. Repair exposed surfaces to match original finish.

3.8 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

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SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes service and distribution panelboards rated 600 V and less, including the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
- B. Related Sections include the following:
 - 1. Division 26 Section "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
 - 2. Division 26 Section "SPD for Low-Voltage Electrical Power Circuits" for internal surge protective devices.

1.2 DEFINITIONS

- A. DPM: Multifunction Digital-Metering Monitor
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. GFEP: Ground-fault equipment protection.
- E. RFI: Radio-frequency interference.
- F. RMS: Root mean square.
- G. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of [normal and] emergency power. [Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.]

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.

- B. Simultaneous Action Submittals: Panelboard Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- C. Product Data: For each type of panelboard, overcurrent protection device, accessory, and related component, include the following:
1. Manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 2. Rated capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
 - a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.
 3. Power Monitoring Block Diagram: Show devices monitored and interconnections between components specified in this Section [and devices furnished under Division 26 Section "Electrical Power Monitoring and Control". Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Illustrate coordination among related equipment and power monitoring and control.
- D. Shop Drawings: For each panelboard and related equipment, include the following:
1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Tabulation of installed devices with features and ratings.
 - b. Enclosure types and details.
 - c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 - d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
 - e. One-line diagram.
 - f. Bus current and voltage ratings.
 - g. Short-time and short-circuit current rating of equipment assembly.
 - h. Feeder entry locations and lug configuration.
 - i. Elevation drawing showing locations for anchor bolts.
 - j. Nameplate legends.
 2. **Seismic Design Calculations:** Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
 3. Wiring Diagrams: For each type of panelboard and related equipment, include the following:
 - a. Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where panelboards are included in the Work.
- B. Manufacturer Seismic Qualification Certification: certification that electrical equipment assemblies, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Panelboard Directories: For installation in panelboards.
- D. Field quality-control Test Method and Procedure: List of procedures to be used during functional and operations sequence testing. Method of Procedure should include but not be limited to the following:
 - 1. Tabulation of Testing Equipment and PPE required for tests.
 - 2. Schedule of Shutdowns required.
 - 3. Manufacturer's Recommended Pre-Start Checklists for the following:
 - a. Overcurrent Protection Devices
 - b. Metering and Monitoring Equipment
 - 4. Step-by-Step Testing Operations and Criteria for tests listed in Part 3 Paragraph "Field quality-control".
- E. Field quality-control test reports including the following:
 - 1. Test results that comply with requirements.
 - 2. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electrical equipment, accessories and components to be included in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for panelboard and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Time-current curves, including selectable ranges for each type of relay and overcurrent protective device. Include directory listing each adjustable breaker included in the Work and their final set points.
 - 4. Manufacturer's sample system checklists and log sheets.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Six spares for each type of panelboard cabinet lock.
 - 2. Touchup Paint: Three 0.5 pint containers of paint matching enclosure finish.
 - 3. Indicating Lights: one for every ten of each type and rating installed. Furnish at least one of each type.
 - 4. Spare Fuses for the following:
 - a. Potential Transformer Fuses: One for every ten of each type and rating installed. Furnish at least one of each type.

- b. Control-Power Fuses: One for every ten of each type and rating installed. Furnish at least one of each type.
- 5. Molded-Case Circuit Breakers rated 100 amperes and less: 1 for every 100 of each type and rating installed. Furnish at least one of each type.]

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer, unless otherwise indicated.
 - 1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.
 - 2. Breaker Manufacturer for installation into existing panelboard: Manufacturer for breakers shall match the manufacturer of the existing equipment. For discontinued equipment, breaker shall be compatible and listed for installation within existing equipment.
- C. Product Options: Drawings indicate spatial allocation for panelboards, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum spatial allocation. Refer to Division 01 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C2.
- F. Comply with NFPA 70.
- G. Comply with NEMA PB 1 "Panelboards".

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

- E. Handle panelboards according to NEMA PB 1.1 and NECA 407.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient Temperature for Circuit Breakers: Not less than [23 deg F and not exceeding] [104 deg F].
 - 2. [Ambient Temperature for Fused Switches: Not less than [minus 22 deg F and not exceeding] [104 deg F].
 - 3. Altitude: Not exceeding [6600 feet (2000 m)]

1.11 COORDINATION

- A. Coordinate layout and installation of panelboard and components with other construction that penetrates floors, ceilings or walls or are supported by them, including but not limited to conduit, piping, other electrical equipment, light fixtures, HVAC equipment, fire-suppression-system components and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer, Inc.; Eaton Corporation.
 - 2. General Electric Co.; Consumer and Industrial Div.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric.

2.2 RATINGS

- A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.
- B. Nominal System Voltage: As indicated on the Drawings.
- C. Main-Bus: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.
- D. Short-Time and Short-Circuit Current: Match rating of highest-rated overcurrent protective device in panelboard assembly.
 - 1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.3 MANUFACTURED UNIT FABRICATION

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Mounting height of breakers shall be in accordance with NFPA 70 requirements. Fabrication of equipment shall take housekeeping pad dimension into account in

determining height of top breaker in all sections. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for housekeeping pad specifications.

- C. Enclosures: Flush- and surface-mounted cabinets, as indicated. NEMA PB 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 - 2. Front Cover: Provide the following, unless otherwise indicated:
 - a. Hinged Front Cover: Door-in-Door construction with entire front trim hinged to box and with standard door within hinged trim cover to access device handles.
- D. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections].
 - a. Lugs: Mechanical styleone or two hole style to suit conditions, suitable for quantity and size of conductor. UL 486 B listed, dual rated and marked for use with copper- or aluminum conductors to suit project conditions.
 - 2. Ground Bus: Hard-drawn copper of 98 percent conductivity, Adequate for feeder and branch-circuit equipment ground conductors; bonded to box. Equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 - 3. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables.
 - 4. Bus Size: Comply with UL 489, including allowance for spare circuit breakers and spaces for future circuit breakers. Include bus to extend the full length of vertical sections.
 - 5. Support and Brace Buses for indicated short-circuit currents.
 - 6. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of panelboard section.
 - 7. Conductor Connectors: Suitable for use with conductor material; dual rated for use with copper- or aluminum conductors; marked AL7CU for 75 degrees C rated circuits.
 - 8. Feed-Through Lugs where indicated on Drawings: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 9. Isolated Equipment Ground Bus, where indicated on Drawings: Adequate for branch-circuit equipment ground conductors; insulated from box.
 - 10. Extra-Capacity Neutral Bus, where indicated on Drawings: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 - 11. Extra-Capacity Neutral Lugs: Where Extra-Capacity Neutral Bus is indicated on Drawings, provided lugs rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Future Device Provision: Equip compartments with unused space with mounting brackets, bus connections, and necessary appurtenances required for future installation of devices. Provide bussing for full length of enclosure section.
- F. DISTRIBUTION PANELBOARDS
 - 1. Door Hardware: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

2. Feeder Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
 - a. Feeder OCPD rated less than [250] Amps: Adjustable Instantaneous-Trip; Bolt-on circuit breakers.
 - b. Feeder OCPD rated [250] Amps and greater: [Adjustable Instantaneous-Trip]; Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
1. Door Hardware: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
 2. Main Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
 - a. Main OCPD rated less than [250] Amps: Adjustable Instantaneous-Trip Circuit Breakers.
 - b. Main OCPD rated [250] Amps and greater: Adjustable Instantaneous-Trip Circuit Breakers.
 3. Branch Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
 - a. Branch OCPD: Thermal-Magnetic; Bolt-on circuit breakers replaceable without disturbing adjacent units.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Series-rated devices are not permitted.
- B. Molded-Case Circuit Breaker Requirements: UL 489, NEMA AB 3, with interrupting capacity rating to meet available fault current.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip-unit circuit breakers: RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
 - a. Long- and short-time pickup levels.
 - b. Long- and short-time time adjustments.
 - c. Instantaneous trip.
 - d. Ground-fault pickup level, time delay, and I^2t response, where indicated.
 - e. Ground-fault indication alarm, where indicated.
 - f. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection and short-time trip function.
- C. Molded-Case Circuit-Breaker Features: Standard frame sizes, trip ratings, and number of poles. Provide the following features for all included in the Work:
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material; UL 486 B listed, dual rated and marked for use with copper- or aluminum load-side conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Lock-Out Tag Provisions: For installing at least three Lock-Out tags on each circuit breaker to secure the breaker and prevent movement mechanism.
- D. Circuit-Breaker Accessories: Standard frame sizes, trip ratings, and number of poles. Provide the following accessories where indicated:

1. Ground-Fault Protection: Provide integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
2. Shunt Trip: Set to trip at 55 percent of rated voltage, where indicated.
3. Communication Capability: Communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
4. Key Interlock Kit: where indicated, provide to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
5. [Under-voltage Trip Devices: Adjustable time-delay and pickup voltage.]
6. Auxiliary Switch: where indicated, provide two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Remote trip indication and control.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces where equipment will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
- B. Examine roughing-in of conduits to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with NECA 407, "Recommended Practice for the Installing and Maintaining Panelboards" as published by the National Electrical Contractors Association.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards and components once unit is secured in place.
- D. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- G. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- H. Install overcurrent protective devices, controllers, and instrumentation.

- I. Install filler plates in unused spaces.
- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- K. For Recessed Panels: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- L. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.
- M. Do not use gutters of panelboards as raceways for routing feeder conductors from bottom entrance to top-feed lugs or vice versa; an external gutter or conduit shall be used for this purpose.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Equipment Identification Nameplates: Label each panelboard with engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."
- C. Distribution Panelboard Feeder OCPD Labels: Label each OCPD with nameplate that indicates the device it feeds using engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."
- D. Panelboard Directory: Create a directory to indicate name/descriptions of installed circuit loads, including final room numbers. Obtain final room numbers from Owner or Signage and Graphics Package. Obtain approval before installing within clear plastic pocket inside panelboard cover. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Diagram and Instructions:
 - 1. Frame and mount the following items in clear acrylic plastic holder on the front of panelboard.
 - a. Operating Instructions: Printed basic instructions for panelboard, including control and key-interlock sequences and emergency procedures where applicable.
 - 2. Storage for Maintenance Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

- A. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Assist in field testing of equipment including pre-testing and adjusting of equipment and components.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. **Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."**
 - 2. Inspect panelboard installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
 - 3. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
- C. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 - 1. After installing panelboard but before equipment is energized, verify that grounding system at panelboard tests to specified value or better.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Section 7.3 for Cables
 - b. Section 7.6 for Circuit Breakers
 - 3. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
 - a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each panelboard. Open or remove doors and covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Complete installation and startup checks according to manufacturer's written instructions.
- D. Correct Deficiencies, Retest and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a report, certified by testing agency, that identifies switchboards, units, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.6 ADJUSTING

- A. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.
 - 1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Coordination Study." are completed.

3.7 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 4. Repair exposed surfaces to match original finish.

3.8 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 262716

ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hinged-Cover Cabinets
2. Terminal Blocks

1.2 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of Cabinet and Enclosures: Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.

C. Shop Drawings: Provide outline Drawings showing dimensions. Include installation and mounting details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where electrical cabinets and enclosures are included in the Work.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electrical cabinets and enclosures, to include in emergency, operation, and maintenance manuals. Provide items specified in Division 01 Section "Operation and Maintenance Data."

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Six spares for each type of cabinet lock.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with NEMA ICS 4, "Terminal Blocks for Industrial Control Equipment and Systems."
- C. Comply with UL 50, "Electrical Cabinets and Boxes"
- D. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate layout and installation of Cabinets and Enclosures and their components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. General Electric Company; Electrical Distribution & Control Division.
 - 3. Hoffman Enclosures, Inc.
 - 4. Siemens Energy & Automation, Inc.
 - 5. Square D; Schneider Electric.

2.2 CABINETS AND ENCLOSURES

- A. Enclosures: Surface-mounted or Free-standing steel cabinets with interior metal panel for mounting terminal blocks and electrical components. Rated for environmental conditions at installed location as follows, unless otherwise indicated:
 - a. Indoor Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- B. Hinged-Type Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover, held closed by flush latch operable by key.
- C. Interior Finish: Manufacturer's white enamel finish over corrosion-resistant treatment or primer coat.
- D. Exterior Finish: ANSI Gray enamel finish over corrosion-resistant treatment or primer coat.
- E. Interior Barriers: Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from wiring operating at or above 50 volts.
- F. Feet: Provide accessory feet for free standing equipment.

2.3 TERMINAL BLOCKS

- A. Terminal Blocks: ANSI/NEMA ICS 4.

- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- D. Provide ground bus terminal block, with each connector bonded to enclosure.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Cabinet and Enclosure Size: As required to accommodate components enclosed or as indicated on Drawings.
- B. Cover Type: Provide Hinged-Type covers on all cabinets, unless otherwise indicated.

3.2 INSTALLATION

- A. Install Cabinets and Enclosures and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim a maximum of 74 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed Cabinets and Enclosures with fronts uniformly flush with wall finish.
- E. Support Cabinets and Enclosures as specified in Division 26 Section "Hangers and Supports for Electrical Systems".

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Cabinet Nameplates: Label each cabinet with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

- B. Correct Deficiencies and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a report, certified by testing agency, that identifies enclosure, units, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.6 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 4. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Hospital-grade receptacles.
 - 3. Weather-resistant receptacles.
 - 4. Automatic plug load controlled receptacles.
 - 5. USB receptacles.
 - 6. Twist-locking receptacles.
 - 7. Pendant cord-connector devices.
 - 8. Cord and plug sets.
 - 9. Switches and wall-box dimmers.
 - 10. Solid-state fan speed controls.
 - 11. Digital time switches.
 - 12. EPO switches.
 - 13. ~~[Communications outlets.]~~
 - 14. Floor service outlets, poke-through assemblies, multioutlet assemblies, and service poles.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for switchbox-mounted occupancy sensors.

1.2 DEFINITIONS

- A. EPO: Emergency power off.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. RFI: Radio-frequency interference.
- F. SPD: Surge Protective Device.
- G. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each type of product indicated under PART 2 – PRODUCTS.
- C. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- D. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for wiring devices and all installed components.
 - 2. Manufacturers' packing label warnings and instruction manuals.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.
- B. Comply with NFPA 99
- C. Comply with NFPA 70

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles. Part numbers listed under products paragraphs in Part 2 articles of this section are included to list the manufacturers' product series and they do not designate the color of the device. Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 2. Leviton Mfg. Company Inc. (Leviton).
 - 3. Pass & Seymour/Legrand; (Pass & Seymour).

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.3 STRAIGHT BLADE RECEPTACLES

- A. Industrial-Grade, Convenience Receptacles, Standard Style, 125 V, 20 A:
1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498, and Federal Specification (FS) W-C-596.
 - b. Description: Industrial Specification Grade receptacles constructed of a high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece brass grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL5361 (simplex), HBL5362 (duplex).
 - b. Leviton; 5361 (simplex), 5362 (duplex).
 - c. Pass & Seymour; 5361 (simplex), 5362A (duplex).
- B. Industrial-Grade, Convenience Receptacles, Decorative Style, 125 V, 20 A:
1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - b. Description: Industrial Specification Grade receptacles constructed of a high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece steel grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL2162 (duplex).
 - b. Leviton; 16351 (simplex), 16352 (duplex).
 - c. Pass & Seymour; 26361 (simplex), 26352 (duplex).
- C. Hospital-Grade, Convenience Receptacles, Standard Style, 125 V, 20 A:
1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 Supplement SD, and Federal Specification (FS) W-C-596.
 - b. Description: Hospital Grade receptacles constructed of high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece nickel-plated brass wrap-around type grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap; Green dot on the face to signify Hospital Grade.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL8310 (simplex), HBL8300 (duplex).
 - b. Leviton; 8310 (simplex), 8300 (duplex).
 - c. Pass & Seymour; 8301 (simplex), 8300 (duplex).
- D. Hospital-Grade, Convenience Receptacles, Decorative Style, 125 V, 20 A:
1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
 - b. Description: Hospital Grade receptacles constructed of high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece steel grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap; Green dot on the face to signify Hospital Grade.
 2. Products: Subject to compliance with requirements, provide one of the following:

- a. Hubbell; HBL2182 (duplex).
- b. Leviton; 16362-HG (duplex).
- c. Pass & Seymour; 26362-HG (duplex).

2.4 GFCI RECEPTACLES

A. Commercial-Grade, GFCI Convenience Receptacles, 125 V, 20 A:

1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498, and UL 943, Class A, and Federal Specification (FS) W-C-596.
 - b. Feed-through type, nominal sensitivity to earth leakage of 4-6 milliamperes; Meeting 2006 CSA/UL requirements for End of Life Provision and Reverse Line-Load Miswire.
 - 1) Device shall either render itself incapable of delivering power or indicate by visual or audible means that the device can no longer provide ground fault protection.
 - 2) Device shall not allow current to pass through device when miswired.
 - c. Description: Commercial Specification Grade receptacle constructed of a high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wiper, T-slot, one-piece copper alloy contact design; One-piece steel grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap.
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GF20xLA.
 - b. Leviton; N7899.
 - c. Pass & Seymour; 2095.

B. Hospital-Grade, GFCI Convenience Receptacles, 125 V, 20 A:

1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6, UL 498 Supplement SD, UL 943, Class A, and Federal Specification (FS) W-C-596.
 - b. Feed-through type, nominal sensitivity to earth leakage of 4-6 milliamperes; Meeting 2006 CSA/UL requirements for End of Life Provision and Reverse Line-Load Miswire.
 - 1) Device shall either render itself incapable of delivering power or indicate by visual or audible means that the device can no longer provide ground fault protection.
 - 2) Device shall not allow current to pass through device when miswired.
 - c. Description: Hospital Grade straight blade receptacle constructed of high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wiper, T-slot, one-piece copper alloy contact design; One-piece nickel-plated brass grounding strap, interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap; Green dot on the face to signify Hospital Grade. LED indicator on face.
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GFR8300HxLA.
 - b. Leviton; N7899-HG.
 - c. Pass & Seymour; 2095-HG.

C. Faceless GFCI Convenience Receptacles, 125 V, 20 A:

1. Requirements:
 - a. Comply with NEMA WD 6, Class A, and UL 943.

- b. Feed-through type, nominal sensitivity to earth leakage of 4-6 milliamperes; Meeting 2006 CSA/UL requirements for End of Life Provision and Reverse Line-Load Miswire.
 - 1) Device shall either render itself incapable of delivering power or indicate by visual or audible means that the device can no longer provide ground fault protection.
 - 2) Device shall not allow current to pass through device when miswired.
 - c. Description: Blank face self test GFCI constructed of high-impact resistant thermo-plastic. Wide-body design; back and side-wired; double wipe, brass contact design; One-piece zinc-plated steel grounding strap; green ground screw and automatic grounding system attached to the strap; Green dot on the face to signify Hospital Grade. LED indicator on face.
2. Products: Subject to compliance with requirements, provide one of the following:
- a. Hubbell; GFSTBF20.
 - b. Leviton; X7590.
 - c. Pass & Seymour; 2085X.

2.5 AUTOMATIC PLUG LOAD CONTROLLED RECEPTACLES

- A. Industrial-Grade, Automatic Plug Load Controlled Convenience Receptacles, Standard Style, 125 V, 20 A:
- 1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498, and Federal Specification (FS) W-C-596.
 - b. Description: Industrial Specification Grade receptacles constructed of a high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece brass grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap.
 - c. Face of receptacle to be imprinted with word "CONTROLLED" and the include symbol as required to meet NFPA 70.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; BR20C1X (half-controlled), BR20C2X (dual-controlled).
 - b. Leviton; 5362-1P (half-controlled), 5362-2P (dual-controlled).
 - c. Pass & Seymour; 5362CHX (half-controlled), 5362CDX (dual-controlled).
- B. Industrial-Grade, Automatic Plug Load Controlled Convenience Receptacles, Decorative Style, 125 V, 20 A:
- 1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - b. Description: Industrial Specification Grade receptacles constructed of a high-impact resistant thermoplastic. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece steel grounding strap; interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap.
 - c. Face of receptacle to be imprinted with word "CONTROLLED" and the include symbol as required to meet NFPA 70.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; DR20C1X (half-controlled), DR20C2X (dual-controlled).
 - b. Leviton; 16352-1P (half-controlled), 16352-2P (dual-controlled).
 - c. Pass & Seymour; 26352CHX (half-controlled), 26252CDX (dual-controlled).

2.6 USB RECEPTACLES

- A. Hospital-Grade, USB, Tamper-Resistant Convenience Receptacles, Decorative Style 125 V, 20 A:
 - 1. Requirements:
 - a. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 AND 1310.
 - b. Description: Hospital Grade receptacle constructed of high-impact resistant thermoplastic with two USB 2.0 charging ports. Wide-body design; back and side-wired; Triple wipe, T-slot, one-piece copper alloy contact design; One-piece steel grounding strap, interlocked into the body in at least 4 points; green ground screw and automatic grounding system attached to the strap; Green dot on the face to signify Hospital Grade.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; USB8300.
 - b. Leviton; T5832-HG.

2.7 SPECIAL CONFIGURATION & TWIST-LOCKING RECEPTACLES

- A. General: NEMA and Non-NEMA configurations as indicated on Drawings.
 - 1. Requirements: Comply with NEMA WD 1, NEMA WD 6; and UL 498.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell.
 - b. Leviton.
 - c. Pass & Seymour.
- B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description:
 - a. Comply with NEMA WD 1, NEMA WD 6 Configuration as indicated on Drawings, and UL 498.
 - b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.8 PENDANT CORD-CONNECTOR DEVICES

- A. General: Matching, locking-type plug and receptacle body connector in NEMA and Non-NEMA configurations as noted on drawings.
 - 1. Requirements:
 - a. Comply with NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and Federal Specification (FS) W-C-596.
 - b. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - c. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell.
 - b. Leviton.
 - c. Pass & Seymour.

2.9 CORD AND PLUG SETS

- A. General: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 1. Requirements:
 - a. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
 - b. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell.
 - b. Leviton.
 - c. Pass & Seymour.

2.10 SWITCHES

- A. General Description: All products listed shall meet the following requirements:
 1. Comply with NEMA WD 1, UL 20; Rated UL-94, V2 or better. Manufacturer shall test all switches for proper operation prior to shipment, sample testing is not acceptable.
 2. Description: Constructed of high-impact arc-resistant thermoplastic; back and side-wired; heavy-gauge copper alloy one-piece arm and silver-cadmium oxide contacts with quiet-action mechanism; heavy-gauge zinc-plated steel-mounting strap with automatic grounding feature. Compatible with fluorescent, tungsten and resistive loads; with a motor load capacity of at least 80% of switch's current rating. Terminal screws shall be brass double-combination: Philips-head, slotted. Mounting screws shall be triple combination: Philips-head, slotted, Robertson.
- B. Toggle Switches, 120/277 V, 20 A:
 1. Requirements: Comply with Federal Specification (FS) W-S-896; Industrial Specification Grade toggle switch.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
 - b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - c. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), PS20AC4 (four way).
- C. Decorative Rocker Switches, 120/277 V, 15 A:
 1. Requirements: Commercial Specification Grade rocker switch.
 2. Products: Subject to compliance with requirements, provide products from one of the following manufacturers:
 - a. Hubbell; DS120 (single pole), DS320 (three-way), DS420 (four-way).
 - b. Leviton; 5621-2 (single pole), 5623-2 (three-way), 5624-2 (four-way).
 - c. Pass & Seymour; 2621 (single pole), 2622 (two pole), 2623 (three-way), 2624 (four-way).

- D. Pilot Light Switches, 120/277 V, and Federal Specification (FS) W-C-596, 20 A:
1. Requirements: Industrial Specification Grade toggle switch; Single pole, with LED or NEON-lighted handle, illuminated when switch is "ON."
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1221PL (single pole), HBL1223PL (3-way) for 120/277V.
 - b. Leviton; 1221-PLC (single pole), 1223-PLC (3-way) for 120 V; 1221-7PLC (single pole), 1223-7PR (3-way) for 277 V.
 - c. Pass & Seymour; PS20AC1-RPL (single pole), PS20AC3-RPL (3-way) for 120 V; PS20AC1-RPL7 (single pole), PS20AC3-RPL7 (3-way) for 277 V.
- E. Illuminated Light Switches, 120/277 V, 20 A:
1. Requirements: Industrial Specification Grade toggle switch; Single pole, with LED or NEON-lighted handle, illuminated when switch is "OFF."
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1221IL (single pole); HBL1223IL (3-way) for 120/277V.
 - b. Leviton; 1221-LHC (single pole), 1223-LHC (3-way) for 120 V; 1221-7LC (single pole) 1223-7LC (3-way) for 277 V.
 - c. Pass & Seymour; PS20AC1-CSL (single pole); PS20AC3-CSL (3-way) for 120/277V.
- F. Key-Operated / Security Switches, 120/277 V, 20 A:
1. Requirements: Single pole, with factory-supplied key in lieu of switch handle. Corbin-style or Barrel lock and key, single-hump key not acceptable.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1221RKL.
 - b. Leviton; 1221-2KL.
 - c. Pass & Seymour; PS20AC1-KL.
- G. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1557.
 - b. Leviton; 1257.
 - c. Pass & Seymour; 1251.
- H. Decorative Rocker Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 15 A:
1. Requirements: Commercial Specification Grade rocker switch.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; 5657-2.
 - b. Pass & Seymour; 2601.
- I. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 24 V.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; 1081.
 - b. Pass & Seymour; 1081.
- A. Decorative Rocker Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 24 V:
1. Requirements: Commercial Specification Grade rocker switch.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; DSM30x2.
 - b. Leviton; 56081-2.

- B. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A;
1. Requirements: with factory-supplied key in lieu of switch handle. Corbin-style or Barrel lock and key, single-hump key not acceptable.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1557L.
 - b. Leviton; 1257L.
 - c. Pass & Seymour; 1251L.

2.11 WALL-BOX DIMMERS

- A. General Description: All products listed shall meet the following requirements:
1. Dimmer Switches: Modular, full-wave, solid-state unit with integral, quiet on-off switch complying with UL 20; audible frequency and EMI/RFI suppression filters.
 2. Comply with ANSI/IEEE standard C62.41-1997 for surge withstand.
 3. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
 4. Memory: Power-failure memory to maintain previously set lighting level upon return of power after outage without human intervention.
- ~~B. Incandescent Lamp Dimmers: 120 V:~~
- ~~1. Requirements: Control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module. Select appropriate rated dimmer from the following; Provide dimmer as required to meet load indicated on Drawings.~~
 - ~~a. 600 W; dimmers shall require no derating when ganged with other devices. [Illuminated when "OFF."]~~
 - ~~b. 1000W; narrow-fin design for single-gang box; dimmers shall require no derating when ganged with other devices. [Illuminated when "OFF."]~~
 - ~~c. 1500W; wide-fin design for double-gang box; dimmers shall require no derating when ganged with other devices. [Illuminated when "OFF."]~~
 - ~~d. 2000W; wide-fin design for double-gang box; dimmers shall require no derating when ganged with other devices. [Illuminated when "OFF."]~~
 - ~~2. Products: Subject to compliance with requirements, provide products from one of the following manufacturers:~~
 - ~~a. Leviton.~~
 - ~~b. Lutron.~~
- ~~C. Fluorescent Lamp Dimmer Switches, 120/277 V:~~
- ~~1. Requirements: Control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module. Modular; compatible with dimmer ballasts as specified under Division 26 Section "Interior Lighting"; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness. Dimmers shall require no derating when ganged with other devices; provide narrow-fin and wide-fin designs as required.~~
 - ~~2. Products: Subject to compliance with requirements, provide products from one of the following manufacturers:~~
 - ~~a. Leviton.~~
 - ~~b. Lutron.~~

2.12 FAN SPEED CONTROLS

- A. Modular, 120-V:

1. Requirements: Full-wave, solid-state units with integral, quiet on-off switches complying with UL20, and audible frequency and EMI/RFI filters. Comply with UL 1917.
 - a. Continuously adjustable slider, 5 A or 1.5 A as required.
 - b. Three-speed adjustable slider, 1.5 A.
2. Products: Subject to compliance with requirements, provide products from one of the following manufacturers:
 - a. Hubbell.
 - b. Leviton.
 - c. Lutron.
 - d. Novitas.
 - e. Pass & Seymour.

2.13 DIGITAL TIME WALL SWITCH (~~Refer the Drawings from Data Center EPO~~)

- A. Requirements: Adjustable time delay up to 2 hours, LCD digital display, Audible or 'Blink' Warning.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 1. Hubbell Building Automation; TD200.
 2. Hubbell; DT1277.
 3. Leviton; LTBxx.
 4. Watt Stopper; TS-400.

2.14 EPO SWITCHES

- A. General Description: All products listed shall meet the following requirements:
 1. Operators shall be heavy duty type and comply with UL Type 13/NEMA Type 13 and UL Type 6/NEMA Type 6.
 2. Contact blocks shall be rated 10 amperes continuous.
- B. Available Products: Subject to compliance with requirements, provide the following as indicated on the Drawings:
 1. Push button type: Flush mounted, two position, momentary push button, red insert, with one normally open and one normally closed (1NO - 1NC) contact. Provide with a hinged, lockable protective cover guard.
 2. Key operated type: Flush mounted, two position, key operated push button, with one normally open and one normally closed (1NO - 1NC) contact. The operator shall be set by rotating the key, with the button in the extended position. The key is removable only in this set position. When pushed, the button will then lock into position. The key must be inserted and rotated to reset to the extended position. Provide with a hinged, lockable protective cover guard.

2.15 WALL PLATES

- A. As defined by and coordinated with the Architect, Single and combination types to match corresponding wiring devices.
 1. Requirements:
 - a. Plate-Securing Screws:
 - 1) Metal with head color to match plate finish.
 - b. Material for Finished Areas: Steel with white baked enamel, suitable for field painting; Smooth, high-impact thermoplastic (nylon); 0.035-inch-thick, satin-finished Type 302/304 Non-Magnetic stainless steel; 0.04-inch-thick, brushed

- brass with factory polymer finish; 0.05-inch-thick anodized aluminum] [0.04-inch-thick steel with chrome-plated finish].
 - c. Material for Utility Areas: Galvanized steel; Smooth, high-impact thermoplastic (nylon); Smooth, high-impact thermoplastic (nylon); exposed devices shall be galvanized steel.
 - d. Material for Unfinished Areas: Galvanized steel; Smooth, high-impact thermoplastic (nylon); Smooth, high-impact thermoplastic (nylon); exposed devices shall be galvanized steel.
 - e. Material for Damp Locations: Thermoplastic (nylon) Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
 - f. Material for Multi-device wall plates over 4-gang: [Steel with baked enamel factory painted to match plastic devices; Steel with white baked enamel, suitable for field painting; 0.04-inch-thick, brushed brass with factory polymer finish; 0.05-inch-thick anodized aluminum; 0.04-inch-thick steel with chrome-plated finish.
 - 2. Products: Subject to compliance with requirements, provide plate from same manufacturer as device.
- B. Wet-Location, Weatherproof Cover Plates:
 - 1. Requirements: NEMA 250, complying with type 3R weather-resistant, extra-duty, while-in-use cover and base with lockable cover; non-removable gasket between the mounting plate/base and cover; stainless steel hinges and mounting hardware.
 - 2. As defined by the Architect, Products: Subject to compliance with requirements, provide one of the following:
 - a. Cover and Base Material: UV resistant polycarbonate.
 - 1) Leviton;
 - a) Horizontal Mount: Clear, 5981-UCL or Gray, 5981-UGY.
 - b) Vertical Mount: Clear, 5981-UCL or Gray, 5981-UGY.
 - 2) Pass & Seymour; Horizontal or Vertical Mount: Frosted, WIUC10FRED.
 - 3) TayMac Corporation; a Division of Hubbell Incorporated;
 - a) Horizontal or Vertical Mount: Clear, MM420C or Gray, MM420G.
 - b. Cover and Base Material: Metal.
 - 1) TayMac Corporation; a Division of Hubbell Incorporated;
 - a) Horizontal Mount: Gray, MX4380S.
 - b) Vertical Mount: [White, MX4280WH Bronze, MX4280Z or [Gray, MX4280S.

2.16 FLOOR SERVICE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell.
 - 2. Thomas & Betts Corporation.
 - 3. Wiremold Company (The).
- B. Requirements as defined by and coordinated with the Architect:
 - 1. Type: Modular, flush-type; flap-type above-floor, dual-service units suitable for wiring method used.
 - 2. Compartments: Barrier separates power from voice and data communication cabling.
 - 3. Service Plate: Rectangular or Round, die-cast aluminum or solid brass with satin finish, powder painted or electro-plated finish.

4. Power Receptacle: NEMA WD 6 configuration 5-20R], Devices as indicated on Drawings, meeting the requirements for receptacles listed in this section above, unless otherwise indicated.
5. ~~Voice and Data Communication Outlet: Blank cover with bushed cable opening Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable], Devices as indicated on Drawings.~~

2.17 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Pass & Seymour/Legrand.
 3. Square D/Schneider Electric.
 4. Thomas & Betts Corporation.
 5. Wiremold Company (The).
- B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly. Comply with UL 514 scrub water exclusion requirements.
 1. Service Outlet Assembly: Pedestal type with services indicated Flush type with two simplex receptacles and space for two RJ-45 jacks Flush type with four simplex receptacles and space for four RJ-45 jacks Devices as Indicated on Drawings.
 2. Size: Selected to fit either nominal 3-inch or 4-inch cored holes in floor and matched to floor thickness.
 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 4. Closure Plug: Arranged to close unused 3-inch or 4-inch cored openings and reestablish fire rating of floor.
 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two or four, 4-pair, Category 5e voice and data communication cables.

2.18 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold Company (The).
- B. Description:
 1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
 2. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Aluminum, Steel, PVC As indicated on Drawings.
- D. Multioutlet Harness:
 1. Receptacles: Meeting the requirements for receptacles listed in this section above, unless otherwise indicated.
 2. Receptacle Spacing: 6 inches; 9 inches; 12 inches; 18 inches. As indicated on Drawings or defined by the architect.
 3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit or two circuit, connecting alternating receptacles as indicated.
- E. Finish: As indicated on Drawings As selected by Architect

- F. Power Receptacle: NEMA WD 6 configuration 5-20R, Devices as indicated on Drawings, meeting the requirements for receptacles listed in this section above, unless otherwise indicated.

~~G. Voice and Data Communication Outlet: Devices as Indicated on Drawings.~~

2.19 SERVICE POLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Wiremold Company (The).
- B. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.
1. Poles: Nominal 2.5-inch-square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
 2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
 3. Finishes: As selected by Architect.
 4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
 5. Power Receptacles: NEMA WD 6 configuration 5-20R, Devices as indicated on Drawings, meeting the requirements for receptacles listed in this section above, unless otherwise indicated.
 6. ~~Voice and Data Communication Outlets: [Blank cover with bushed cable opening] [Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable] [Devices as Indicated on Drawings].]~~

2.20 FINISHES

- A. Color: Wiring device catalog numbers in Section Text above do not designate device color. The wiring devices and associated wall plates shall conform to the colors listed in Table 1 below or as otherwise required by NFPA 70. Final color selections for all devices and wall plates shall be submitted to and approved by the Architect.
1. * Indicates: Provide Orange Triangle on device to Indicate Isolated Ground Receptacle
 2. ** Indicates: Engrave (Metal) or Hot Stamp (Thermoplastic) as indicated in "Identification" paragraphs of PART 3 - Execution section.

Table 1

<u>Connected to Normal Power in Finish Areas</u>	<u>Device</u>	<u>Wall Plate</u>	<u>Lettering**</u>
Standard NEMA 5-20R Receptacles	White	White	Black
Isolated Ground NEMA 5-20R Receptacles	White*	White	Black
Tamper Resistant NEMA 5-20R Receptacles	White	White	Black
GFCI NEMA 5-20R Receptacles	White	White	Black
Auto Plug Load Controlled NEMA 5-20R Receptacles	White	White	Black
USB NEMA 5-20R Receptacles	White	White	Black
SPD NEMA 5-20R Receptacles	Blue	White	Black
IG-SPD NEMA 5-20R Receptacles	Blue*	White	Black

Switches & Wall Box Dimmers	White	White	Black
Switchbox-Mounted Occupancy Sensors	White	White	Black
<u>Connected to Normal Power in Utility Areas</u>	<u>Device</u>	<u>Wall Plate</u>	<u>Lettering**</u>
Standard NEMA 5-20R Receptacles	White	Metal	Black
GFCI NEMA 5-20R Receptacles	White	Metal	Black
Switches	White	Metal	Black
Switchbox-Mounted Occupancy Sensors	White	Metal	Black

<u>Connected to Emerg. Pwr. in Finish Areas</u>	<u>Device</u>	<u>Wall Plate</u>	<u>Lettering**</u>
Standard NEMA 5-20R Receptacles	Red	Red	White
Isolated Ground NEMA 5-20R Receptacles	Red*	Red	White
Tamper Resistant NEMA 5-20R Receptacles	Red	Red	White
GFCI NEMA 5-20R Receptacles	Red	Red	White
Auto Plug Load Controlled NEMA 5-20R Receptacles	Red	Red	White
USB NEMA 5-20R Receptacles	Red	Red	White
SPD NEMA 5-20R Receptacles	Blue	Red	White
IG-SPD NEMA 5-20R Receptacles	Blue*	Red	White
Switches & Wall Box Dimmers	Red	Red	White
Switchbox-Mounted Occupancy Sensors	White	Red	White
<u>Connected to Emerg. Pwr. in Utility Areas</u>	<u>Device</u>	<u>Wall Plate</u>	<u>Lettering**</u>
Standard NEMA 5-20R Receptacles	Red	Metal	Red
GFCI NEMA 5-20R Receptacles	Red	Metal	Red
Switches	Red	Metal	Red
Switchbox-Mounted Occupancy Sensors	White	Metal	Red

<u>Connected to UPS Power System</u>	<u>Device</u>	<u>Wall Plate</u>	<u>Lettering**</u>
Isolated Ground NEMA 5-20R Receptacles	Orange	White	Black
Under-floor Isolated Ground NEMA 5-20R Receptacles	Orange	Metal	Black
Switchbox-Mounted Occupancy Sensors	Orange	White	Black

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following for all indoor applications, as defined by and coordinated with the architect, unless otherwise indicated:
 1. Receptacle Grade: Hospital-Grade or Industrial Grade as determined by review of governing authority having jurisdiction. Contractor to have adder price available as necessary for specific areas of the building.
 2. Receptacle Style: Decorative (Rectangular Face)
 3. Switch Style: Decorative Rocker
- B. Receptacles in Patient Care Areas: Install Hospital Grade devices where device is located within a simulated Patient Care Area as defined by NFPA 70 Article 517 or the Authorities Having Jurisdiction, unless industrial grade is sufficient.

- C. GFCI Receptacles: Install in locations as indicated but in no case less than those listed below:
 - 1. Where device is located on the exterior of the building, provide with Wet-Location Weatherproof Cover Plate.
 - 2. Where device is located within kitchen.
 - 3. Where device is located within a garage.
 - 4. Where device is located in an elevator pit.
 - 5. Where device is located within 6 feet (2-m) of a lavatory or sink, except where located on patient headwall].
- D. Tamper-Resistant Receptacles: Install in locations as indicated but in no case less than those listed below:
 - 1. Public Lobbies.
 - 2. Waiting Rooms.
 - 3. Play Rooms and other similar rooms that children are expected to occupy.

3.2 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise indicated.
- B. Mounting Heights: Comply with applicable codes and requirements of Authorities Having Jurisdiction. Mount devices as listed below or as otherwise indicated on Drawings, including but not limited to Architectural elevations. Coordinate all above counter receptacles with backsplash to avoid interferences. All dimensions are given to centerline of box above finished floor (AFF), unless otherwise indicated.
- C. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
 - 5. Install wiring devices with appropriate backbox and raceway according to room finish (i.e. flush mounted devices in recessed backboxes with concealed conduit in finished spaces; surface mounted boxes with exposed conduit in unfinished spaces. Refer to Architectural Documents for room finish types.
- E. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
- F. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until substantial completion.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Mount Switches or Wall Box Dimmers within 6 inches of door frame, unless otherwise indicated.
11. Install Isolated-Ground devices so as not to bond the ground pole or isolated ground conductor (green/yellow) to the conduit system or equipment ground conductor (green).
12. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical.

G. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up and on horizontally mounted receptacles to the left (i.e. neutral blade at the top).

H. Device Plates and Covers:

1. Do not use oversized or extra-deep plates.
2. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
3. Install weather-proof-while-in-use covers over receptacles in wet, damp and exterior locations.
4. Group adjacent devices under single, multigang wall plates.

I. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

J. Floor Service Outlets, Service Poles and Poke-Thru Device

1. Adjust locations of floor service outlets, service poles, and Poke-Thru devices to suit arrangement of partitions and furnishings. Coordinate revised location with Structural Engineer.
2. Install Poke-Thru devices within their listing. Install devices so there is no more than 1 device per 64-square-feet (5.95-Square-meters) of floor area and so there is no less than 2-feet (.61-m) separation between adjacent devices.

3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

1. On the backside of wiring device wall plates identify with a black permanent marking pen the panelboard and branch circuit number the device is served from.
2. Receptacles: Identify panelboard and circuit number from which served on all receptacles Hot Stamped for Thermoplastic wall plates. All lettering shall be filled on face of plate, lettering color as indicated in the table in Part 2 above.
3. Switches: Identify panelboard and circuit number from which served on [All Switches Hot Stamped for Thermoplastic wall plates. All lettering shall be filled on face of plate, lettering color as indicated in the table in Part 2 above.
4. Provide price option for all receptacle and switch ID's to applied with KROY sticky back-labeling.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. For EPO switches, provide 120V power where control power is not provided from equipment.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems.
 2. Tests for Convenience Receptacles:
 - a. Line Voltage: Acceptable range is 105 to 132 V.
 - b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - c. Ground Impedance: Values of up to 2 ohms are acceptable.
 - d. Polarity: test for correct neutral conductor to neutral terminal connection.
 - e. Using the test plug, verify that the device and its outlet box are securely mounted.
 - f. GFCI Receptacles: Test for tripping values specified in UL 1436 and UL 943.
 3. Test Instruments:
 - a. Use instruments that comply with UL 1436.
 - b. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Correct Deficiencies and Report:
 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace devices as required to bring system into compliance.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Prepare a report, certified by testing agency, that identifies enclosure, units, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- C. Wiring device will be considered defective if it does not pass tests and inspections.

3.6 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. On completion of device box installation but before any wiring devices are installed, inspect interior of boxes and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of wall plate installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Replace cracked or damaged wall plates.
 - 4. Wipe down all wall plates with approve cleaning agent to remove fingerprints and dust.

END OF SECTION

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in the following:
 - a. Control circuits.
 - b. Enclosed Switches
 - c. Elevator Switches

1.2 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Simultaneous Action Submittals: Fuse Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- C. Product Data: Include the following:
 - 1. For each fuse type indicated, provide dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc.
 - 4. Tabulated schedule which indicates type, characteristics, and ratings of individual fuses and lists the devices and equipment in which they will be applied.
 - 5. Fuse size for elevator feeders and elevator disconnect switches.

- D. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Let-through current curves for fuses with current-limiting characteristics.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Ambient temperature adjustment information.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to one for every ten of each type and rating installed. Furnish at least three of each type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single source from a single manufacturer.
- B. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels. Provide fuses to match utilization equipment requirements.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size. Provide fuses to match utilization equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman; a division of Cooper Industries.
 - 2. Edison; a brand of Cooper Bussman; a division of Cooper Industries.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.
 - 5. Mersen USA.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

2.3 SPARE-FUSE CABINET (FOR ELEVATOR FUSES)

- A. Cabinet: Wall-mounted, 0.05-inch-thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: ANSI Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Service Entrance: Class L, time delay.
- B. Feeders rated 600 Amperes or less: Class RK1, time delay.
- C. Feeders rated 601 Amperes and above: Class L, time delay.
- D. Motor Branch Circuits: Class RK1, time delay.
- E. Large Motor Branch (601-4000 A): Class L, time delay.
- F. Other Branch Circuits: Class RK1, time delay.

- G. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).
- C. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.4 IDENTIFICATION

- A. Install labels complying with identification requirements in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch.
- B. Install labels indicating Type and Rating of fuse installed on outside of door of each fused switch.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers.
 - 4. Enclosures.

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. GFEP: Ground-fault equipment protection.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.3 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Simultaneous Action Submittals: Enclosed Switches and Circuit Breaker Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement.

The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.

- C. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable circuit breaker.
- D. Shop Drawings: For each enclosed circuit breaker, switch and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of device and overcurrent protective devices.
 - 2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for enclosed switches and circuit breakers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 3. Time-current curves, including selectable ranges for each type of circuit breaker. Include directory listing each adjustable breaker included in the Work and their final set points.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories through one source from a single manufacturer, unless otherwise indicated.
 - 1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Product Options: Drawings indicate spatial allocation for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum spatial allocation. Refer to Division 01 Section "Product Requirements."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation at indicated ampere ratings for the following conditions:
 - 1. Ambient Temperature for Circuit Breakers: Not less than 23 deg F and not exceeding 104 deg F.
 - 2. Ambient Temperature for Fused Switches: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 3. Altitude: Not exceeding 6600 feet (2000 m)

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate ratings with utilization equipment nameplate limitations of maximum overcurrent protection device size. Provide enclosed switch or circuit breakers to match utilization equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Consumer and Industrial Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.
- B. Fusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.
- E. Fuses are specified in Division 26 Section "Fuses."

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.
- B. Series-rated devices are not permitted.
- C. Molded-Case Circuit Breaker Requirements: UL 489, NEMA AB 3, with interrupting capacity rating to meet available fault current.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers: RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:
 - a. Long- and short-time pickup levels.
 - b. Long- and short-time time adjustments.

- c. Instantaneous trip.
 - d. Ground-fault pickup level, time delay, and I^2t response, where indicated.
 - e. Ground-fault indication alarm, where indicated.
 - f. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection and short-time trip function.
- D. Molded-Case Circuit-Breaker Features: Standard frame sizes, trip ratings, and number of poles. Provide the following features for all included in the Work:
- 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material; UL 486 B listed, dual rated and marked for use with copper- or aluminum load-side conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Lock-Out Tag Provisions: For installing at least three Lock-Out tags on each circuit breaker to secure the breaker and prevent movement mechanism.
- E. Circuit-Breaker Accessories: Standard frame sizes, trip ratings, and number of poles. Provide the following accessories where indicated:
- 1. Ground-Fault Protection: Provide integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 2. Shunt Trip: Set to trip at 55 percent of rated voltage, where indicated.
 - 3. Communication Capability: Communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - 4. Key Interlock Kit: where indicated, provide to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 5. Under-voltage Trip Devices: Adjustable time-delay and pickup voltage.
 - 6. Auxiliary Switch: where indicated, provide two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 7. Remote trip indication and control.
- F. Molded-Case Switch Requirements: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- G. Molded-Case Switch Features and Accessories:
- 1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 1. Under-voltage Trip Devices: Adjustable time-delay and pickup voltage
 - 2. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 3. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.

2.4 ELEVATOR SHUNT-TRIP DISCONNECT SWITCHES

- A. Manufacturers:
- 1. Eaton Corporation; Cutler-Hammer Products – ES Elevator Switch
 - 2. Cooper Bussmann, Inc. Model - Power Module Switch - PS
 - 3. Littelfuse, Inc. Model - LPS Series Elevator POWR-Switch

- B. Fusible Switch with Shunt-Trip: Manufactured unit that combines fused disconnect switch with all necessary relay(s), control transformer and other options, required to provide disconnecting means and fire protection shunt-trip interface for elevator controller.
1. Ampere Rating: As required by elevator manufacturer for elevator proposed for inclusion in the Work.
 2. Short-Circuit Current Rating: 200,000A.
 3. Interlocks to prevent the opening of the cover when the switch is in the ON position. Interlock shall be defeatable for testing purposes.
 4. Handle: lockable in the OPEN/OFF position.
 5. Control Power Transformer: Integral 100VA rated with primary and secondary fuses. Primary voltage rating of 480 VAC with a 120 VAC secondary.
 6. Isolation relay (3PDT, 10amp, 120V): Provide isolation relay with 120V AC or 24V DC coil as required to coordinate fire alarm system.
 - a. Coordinate a normally open dry contact to energize the isolation relay and activate the shunt trip solenoid (140VA inrush at 120V); relay provided under Division 28 Section "Fire Alarm System". If 24V DC coil is selected, a separate 24V DC source and contact shall be provided by the Fire Alarm Safety System.
 7. Provide options as follows:
 - a. Key to Test Switch
 - b. Pilot Light indicating systems is in the CLOSED/ON position.
 - c. Isolated Full Capacity Neutral Lug
 - d. For hydraulic elevators with automatic recall: Provide one pole normally closed Mechanical Interlock.
 - e. Fire Alarm Voltage Monitoring Relay; Comply with NFPA 72.

2.5 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location as follows, unless otherwise indicated:
1. Indoor Locations: NEMA 250, Type 1.
 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 3. Outdoor Locations: NEMA 250, Type 3R.
 4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- B. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat, undersurfaces treated with corrosion-resistant undercoating.
- C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces where equipment will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
- B. Examine roughing-in of conduits to verify the following:
1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

- C. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Fused Power Circuit Device Operating Mechanism: Mechanical Trip, except Electrical Trip for switches with ground-fault protection or remotely tripped switches.
- B. Molded-Case Circuit Breakers OCPD Type: Thermal-Magnetic Circuit Breakers Adjustable Instantaneous-Trip Circuit Breakers Electronic Trip-Unit Circuit Breakers, as indicated required for the installation.

3.3 INSTALLATION

- A. Install and anchor equipment level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
- B. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated.
- G. Anchor floor-mounting switches to concrete base.
- H. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- I. Mount plumb and rigid without distortion of box. Mount recessed equipment with fronts uniformly flush with wall finish.
- J. Install overcurrent protective devices, controllers, and instrumentation.
- K. Install filler plates in unused spaces.
- L. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- M. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.
- N. Do not use gutters of equipment as raceways for routing feeder conductors from bottom entrance to top-feed lugs or vice versa; an external gutter or conduit shall be used for this purpose.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Enclosure Nameplates: Label each enclosure with engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."

3.5 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each equipment bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Verify switch and relay type and labeling verification.
 - 4. Verify rating of installed fuses.
 - 5. Assist in field testing of equipment including pre-testing and adjusting of equipment and components.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 - 2. Inspect equipment installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
 - 3. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
 - 4. Complete installation and startup checks according to manufacturer's written instructions.
- C. Correct Deficiencies, Retest and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a report, certified by testing agency, that identifies switchboards, units, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.7 ADJUSTING

- A. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.
 - 1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Coordination Study." are completed.

3.8 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 4. Repair exposed surfaces to match original finish.

3.9 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain enclosed switches and circuit breakers, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 262913

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
 - 2. Reduced-voltage controllers.
 - 3. Multi-speed controllers.
- B. Related Sections include the following:
 - 1. ~~Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.~~
 - 2. Division 23 Sections for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
 - 3. Division 26 Section "SPD for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors.

1.2 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Simultaneous Action Submittals: Enclosed Controller Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- C. Product Data: For each type of enclosed controller and related component, include the following:

1. Manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 2. For enclosed controllers with integral overcurrent protection devices, provide rated capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
 - a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.
 3. Power Monitoring Block Diagram: Show devices monitored and interconnections between components specified in this Section and devices furnished under Division 26 Section "Electrical Power Monitoring and Control". Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Illustrate coordination among related equipment and power monitoring and control.
- D. Shop Drawings: For each enclosed controller and related equipment, include the following:
1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
 - a. Enclosure types and details.
 - b. Outline and general arrangement drawing showing dimensions and weights of each assembled section.
 - c. Short-circuit current rating of equipment assembly.
 - d. Feeder entry locations and lug configuration; including size and number of conductors accepted for phase, neutral, and ground conductors.
 - e. Nameplate legends.
 2. **Seismic Design Calculations:** Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
 3. Wiring Diagrams: For each type of enclosed controller and related equipment, include the following:
 - a. Power, signal, and control wiring.
 - b. Schematic control diagrams.
 - c. Diagrams showing connections of component devices and equipment.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where enclosed controllers are included in the Work.
- B. Field quality-control Test Method and Procedure: List of procedures to be used during functional and operations sequence testing. Method of Procedure should include but not be limited to the following:
 1. Tabulation of Testing Equipment and PPE required for tests.
 2. Schedule of Shutdowns required.
 3. Manufacturer's Recommended Pre-Start Checklists for the following:
 - a. Overcurrent Protection Devices
 - b. Metering and Monitoring Equipment
 4. Step-by-Step Testing Operations and Criteria for tests listed in Part 3 Paragraph "Field quality-control".

- C. Field quality-control test reports including the following:
 - 1. Test results that comply with requirements.
 - 2. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electrical equipment, accessories and components to be included in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Time-current curves, including selectable ranges for each type of relay and overcurrent protective device. Include directory listing each adjustable breaker included in the Work and their final set points.
 - 4. Manufacturer's sample system checklists and log sheets.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: One for every ten of each type and rating installed. Furnish at least one of each type.
 - 2. Indicating Lights: one for every ten of each type and rating installed. Furnish at least one of each type.
 - 3. Touchup Paint: Three 0.5 pint containers of paint matching enclosure finish.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain enclosed controllers, components, and accessories through one source from a single manufacturer, unless otherwise indicated.
- C. Product Options: Drawings indicate spatial allocation for enclosed controllers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum spatial allocation. Refer to Division 01 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- E. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.9 COORDINATION

- A. Coordinate layout and installation of enclosed controllers and components with other construction that penetrates floors, ceilings or walls or are supported by them, including but not limited to conduit, piping, other electrical equipment, light fixtures, HVAC equipment, fire-suppression-system components and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
 - 2. Cerus Industrial.
 - 3. Danfoss Inc.; Danfoss Electronic Drives Div.
 - 4. Eaton Corporation; Cutler-Hammer Products.

5. General Electrical Company; GE Industrial Systems.
6. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
7. Siemens/Furnas Controls.
8. Square D.

2.2 RATINGS

- A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.
- B. Nominal System Voltage: As indicated on the Drawings.
- C. Amperage: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.
- D. Short-Circuit Current: Match rating of overcurrent protective device serving enclosed controller assembly.
 1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.3 MANUFACTURED UNIT FABRICATION

- A. Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets, as indicated.
 1. Rated for environmental conditions at installed location.
 - a. Indoor Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 2. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat, undersurfaces treated with corrosion-resistant undercoating.
 3. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.
- C. Hand-off-automatic switch: Three-position selector switch.

2.4 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer or from a control power ~~transformer~~ source of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10, 20 or 30 tripping characteristic as appropriate. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10, 20 or 30 tripping characteristic, as appropriate and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.5 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

- A. Wye-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.
- B. Part-Winding Controller: NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.
- C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.
- D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
 2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 3. LED indicators showing motor and control status, including the following conditions:
 - a. Control power available.
 - b. Controller on.
 - c. Overload trip.
 - d. Loss of phase.
 - e. Shorted silicon-controlled rectifier.
 4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
 5. Motor running contactor operating automatically when full voltage is applied to motor.

2.6 MULTI-SPEED ENCLOSED CONTROLLERS

- A. Multi-speed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
1. Compelling relay to ensure that motor will start only at low speed.
 2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.

3. Decelerating relay to ensure automatically timed deceleration through each speed.
4. Match multi-speed enclosed controller to motor. Coordinate with motor specified under Division 23 Section "Common Motor Requirements for HVAC Equipment.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Provide the following factory-installed devices within the controller enclosure, unless otherwise indicated:
 1. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
 2. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
 3. Control Relays: Auxiliary and adjustable time-delay relays.
 4. Elapsed Time Meter: Heavy duty with digital readout in hours.
 5. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.
 6. Current-Sensing, Phase-Failure Relays for Bypass Controllers: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.
 7. Auxiliary Contacts: For remote indication or initiation of controller, with spare auxiliary switches and other auxiliary switches required for normal operation. Provide two sets of contacts arranged with two normally open contacts and two normally closed contacts. Sets shall be removable and field-convertible. Wire contacts through secondary disconnect devices to a terminal block in stationary housing.

2.8 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Ratios with accuracy class and burden suitable for connected relays, meters, and instruments.
- ~~B. Power Monitor: Provide monitoring and metering equipment according to Division 26 Section "Electrical Power Monitoring and Control."~~
- C. Power Monitor: Microprocessor-based Multifunction Digital-Metering Monitor unit suitable for three- or four-wire systems and with the following features:
 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

- i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
- 2. Mounting: Display and control unit flush or semi-flush mounted in panel cover trim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces where equipment will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
- B. Examine roughing-in of conduits to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.
 - 1. Coordinate motor starter size with motor supplied under other divisions of these specifications prior to procurement.
 - 2. Supply overloads rated to match motor supplied under other divisions of these specifications prior to procurement.

3.3 INSTALLATION

- A. Comply with NECA 230, "Standard for Selecting, Installing, and Maintaining Electric Motors and Motor Controllers (ANSI)" as published by the National Electrical Contractors Association.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosed controllers and components once unit is secured in place.
- C. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
 - 1. For control equipment at walls: Mount on Steel Slotted Support Systems complying with Division 26 Section "Hangers and Supports for Electrical Systems."
 - 2. For controllers not at walls: Provide freestanding Steel Slotted Support Systems complying with Division 26 Section "Hangers and Supports for Electrical Systems."
 - 3. For free-standing floor-mounted controllers: Install and anchor equipment level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- F. Mount plumb and rigid without distortion of box. Mount recessed enclosed controllers with fronts uniformly flush with wall finish.
- G. Install overcurrent protective devices, controllers, and instrumentation.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.
- J. Do not use gutters of enclosure as raceways for routing feeder conductors from bottom entrance to top-feed lugs or vice versa; an external gutter or conduit shall be used for this purpose.
- K. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Equipment Identification Nameplates: Label each enclosed controller with engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."

3.5 CONNECTIONS

- A. Tighten electrical connectors, and terminals according to manufacturer's published torque-tightening values.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.
 3. Assist in field testing of equipment including pre-testing and adjusting of equipment and components.
- B. Perform the following field tests and inspections and prepare test reports:
1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 2. Inspect enclosed controller installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
 3. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following field tests and inspections and prepare certified test reports:
1. Complete installation and startup checks according to manufacturer's written instructions.
- D. Correct Deficiencies, Retest and Report:
1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace conductors, units, and devices as required to bring system into compliance.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Prepare a report[, certified by testing agency,] that identifies enclosed controller, units, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.7 ADJUSTING

- A. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.
1. Coordination Study will be completed by Engineer-of-Record after completion of the submittal process.
 2. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Coordination Study" are completed.

3.8 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
1. Remove paint splatters and other spots.
 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
1. Remove paint splatters and other spots.
 2. Remove all temporary markings and labels.
 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

4. Repair exposed surfaces to match original finish.

3.9 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain enclosed controllers, overcurrent protective devices, instrumentation, and accessories. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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SECTION 262923

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Requirements:
 - 1. Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.2 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. OCPD: Overcurrent protective device.
- I. PID: Control action, proportional plus integral plus derivative.
- J. RFI: Radio-frequency interference.
- K. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
 - 1. Include dimensions and finishes for VFCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated.
 - 1. Include mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Required working clearances and required area above and around VFCs.
 2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
 3. Show support locations, type of support, and weight on each support.
 4. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Seismic Qualification Certificates: For each VFC, accessories, and components, from manufacturer.
 1. Certificate of compliance.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.
- D. Product Certificates: For each VFC from manufacturer.
- E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.

- d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
- e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
- f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCT

2.1 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
 - 1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A UL 508C.
- B. Application: Constant torque and variable torque.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 97 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
 7. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet (1000 m).
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 5 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.

2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
 3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 4. Under- and overvoltage trips.
 5. Inverter overcurrent trips.
 6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 7. Critical frequency rejection, with three selectable, adjustable deadbands.
 8. Instantaneous line-to-line and line-to-ground overcurrent trips.
 9. Loss-of-phase protection.
 10. Reverse-phase protection.
 11. Short-circuit protection.
 12. Motor-overtemperature fault.
- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 5. NC alarm contact that operates only when circuit breaker has tripped.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

2.3 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
 2. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).

3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 4. Output Signal Interface: A minimum of two programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
 5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
1. Number of Loops: Two.
- G. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.
1. Hardwired Points:
 - a. Monitoring:
 - 1) On-off status.
 - 2) General alarm.
 - b. Control:
 - 1) On-off operation.
 - 2) Speed Feedback.
 2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.4 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
- B. Output Filtering: Less than 5% distortion based on building study..
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.5 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.
- D. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
 - 1. Bypass Contactor: Load-break, NEMA-rated contactor.
 - 2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
 - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- E. Bypass Contactor Configuration: Reduced-voltage (autotransformer) type.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
 - 4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120 -V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 50 VA.
6. Overload Relays: NEMA ICS 2.
 - a. Melting-Alloy Overload Relays:
 - 1) Inverse-time-current characteristic.
 - 2) Class 20 tripping characteristic.
 - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - b. Bimetallic Overload Relays:
 - 1) Inverse-time-current characteristic.
 - 2) Class 20 tripping characteristic.
 - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - 4) Ambient compensated.
 - 5) Automatic resetting.
 - c. Solid-State Overload Relays:
 - 1) Switch or dial selectable for motor-running overload protection.
 - 2) Sensors in each phase.
 - 3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 5) Analog communication module.
 - d. NC isolated overload alarm contact.
 - e. External overload, reset push button.

2.6 OPTIONAL FEATURES

- A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.
 1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
 2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
 3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.
- B. Damper control circuit with end-of-travel feedback capability.

- C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
- D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.
- E. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station or smoke-control fan controller, this password-protected input:
 - 1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
 - 2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
 - 3. Forces VFC to transfer to bypass mode and operate motor at full speed.
 - 4. Causes display of override mode on the VFC display.
 - 5. Reset VFC to normal operation on removal of override signal automatically.
- F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- G. Remote digital operator kit.
- H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.7 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 4X.
 - 3. Areas: Type 4X.
 - 4. Other Wet or Damp Indoor Locations: [Type 4] <Insert type>.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.8 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - 1. Push Buttons: Shielded.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
 - 4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. NC bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- E. Supplemental Digital Meters:
 - 1. Elapsed-time meter.
 - 2. Kilowatt meter.
 - 3. Kilowatt-hour meter.
- F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- H. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.
- I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- J. Spare control-wiring terminal blocks; wired.

2.9 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
 - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Floor-Mounting Controllers: Install VFCs on **4-inch (100-mm)** nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
- C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than **79 inches (2000 mm)** above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
 - 1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
 - 2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."
- D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Install fuses in each fusible-switch VFC.
- G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFC with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).

5. Test each motor for proper phase rotation.
 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. VFCs will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.

- E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
- F. Set field-adjustable pressure switches.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 263213

ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged engine-generator sets for use as a legally required emergency generator with the following major features:
 - 1. Diesel engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Outdoor enclosure.
- B. Emergency Generator Summary
 - 1. Provide an emergency standby diesel-powered engine-generator set to support the following loads:
 - a. Data Center UPS
 - b. Data Center cooling (in-row DX split system coolers)
 - c. Atrium & classroom smoke exhaust fans and associated main AHU supply air fans to operate in conjunction with the smoke exhaust fans.
 - d. Control dampers for AHU-1 supply fans shall be included.
 - e. Jockey pump and fire pump
 - f. Emergency egress and exit lighting
 - g. Fire alarm system
 - h. FCU's for main and branch electrical rooms
 - i. FCU's for MDF and IDF rooms
 - j. One elevator at a time during emergency operation.
- C. The genset shall be rated 300 KW at 0.8 PF, 480Y/277V as manufactured by Cummins (equal to model DQDAC), Caterpillar, Kohler, or MTU. The genset shall be a UL2200 self-contained assembly that consists of the following major components:
 - 1. Engine,
 - 2. 125c alternator,
 - 3. Main line circuit breaker,
 - 4. Unit mounted radiator,
 - 5. Flat "hockey puck" style critical grade muffler/silencer,
 - 6. Fixed air intake louvers,
 - 7. Gravity radiator air discharge louvers, and
 - 8. Directional air discharge shroud
 - 9. All enclosed within an 85 db weatherproof enclosure set on top of a sub-base fuel storage tank constructed in accordance with UL2085 standards that requires a double steel wall with a Concrete interstitial cavity sized for 24 hours of operation and maximum tank fill of 90%.
 - 10. The engine will draw its fuel directly from the sub-base tank.
 - 11. The assembly shall be provided with the following auxiliary accessories:
 - a. Batteries and battery charger
 - b. Water jacket heater(s)
 - c. Alternator strip heater
 - d. Remote annunciator panel
 - e. Lighting and convenience receptacles inside enclosure
 - f. Ground fault indication

- g. The genset shall be provided with a data gateway to transmit genset operational, trouble, and alarm data to the FMS.
- h. The manufacturer shall provide full start-up services and full functional performance acceptance testing with a 12 hour 100% load burn-in and final pull-the-plug system test. Provide full certified test report.

1.2 Related Sections include the following:

- A. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- B. LP: Liquid petroleum.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design outdoor generator-set enclosure and sub-base tank, including comprehensive engineering analysis by a UL certified company, using performance requirements and design criteria indicated.
- B. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.
- C. System Function: The engine generator system shall include the capability of being automatically controlled. After starting, the unit shall attain rated speed and voltage, and accept rated load. Generator set speed shall be controlled by the engine governor, while generator output voltage regulation shall be a function of the generator automatic voltage regulator. Manual adjustment of generator speed and voltage shall be provided.

1.5 ACTION SUBMITTALS

- A. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section "Common Work Results for Electrical".
- B. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- C. Simultaneous Action Submittals: Engine Generator Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section

"Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.

- D. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
1. Thermal damage curve for generator.
 2. Time-current curves for each generator overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable circuit breaker.
 3. Fuel System:
 - a. Fuel consumption at: 50-percent rated load, 75-percent rated load and 100-percent rated load.
 - b. Fuel flow at 100-percent rated load.
 - c. Manufacturer Safety Data Sheet for fuel oil
 4. Electrical Characteristics:
 - a. Power rating at 0.8 power factor lagging
 - b. Motor starting, maximum kVA at 90-percent sustained voltage
 - c. Fault current, 3-phase symmetrical
 - d. Number of Poles
 - e. Per Unit Impedance, positive (X'' and X/R ratio)
 - f. Per Unit Impedance, negative (X'' and X/R ratio)
 - g. Per Unit Impedance, zero (X'' and X/R ratio)
 - h. Resistance Stator resistance measured at dc current (R_a)
 - i. Resistance, positive sequence short circuit resistance (r_g)
 - j. Resistance, zero sequence short circuit resistance. (r_o)
 - k. Reactance, subtransient reactance saturated value. 1- to 5-cycle reactance. (X_d'')
 - l. Reactance, transient reactance saturated value. 5- to 200-cycle reactance (X_d')
 - m. Reactance, synchronous reactance saturated value. Above 200 cycles (X_d)
 - n. Reactance, zero sequence short circuit reactance (x_o)
 - o. Time Constant, subtransient time constant (T_d'')
 - p. Time Constant, transient time constant (T_d')
 - q. Time Constant, DC time constant (T_{dc})
 - r. Time Constant, armature short circuit time constant (T_a)
 - s. Field current at given load. Actual pre-fault amperes at the initial loading conditions (I_f)
 - t. Field current at no load rated volts (I_{fg})
 - u. Impedance, neutral Impedance R
 - v. Impedance, neutral Impedance X
 - w. Reactance, Quadrature axis subtransient reactance (saturated) of synchronous machines. (X_q'')
 5. Coolant System:
 - a. Total airflow required including, but not limited to, combustion air, alternate cooling air and radiator cooling air in supply cfm.
 - b. Maximum static airflow restriction of the system in inches of water column.
 6. Exhaust System:
 - a. Maximum allowable exhaust backpressure.
 - b. Exhaust gas flow rate.
 - c. Exhaust stack temperature.

- d. Record of Exhaust Emissions tests for compliance with EPA TIER requirements for the project location.
- 7. Acoustical Silencer Assembly: Maximum allowable external static pressure.
- E. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Total weight of system including, but not limited to, generator, alternator, engine, base, supports, sub-base fuel tank filled with fuel, radiator and enclosure.
 - 3. **Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.**
 - 4. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 - 5. Wiring Diagrams: Power, signal, and control wiring.
 - 6. Exhaust pipe connection and size.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each interior location where generators are included in the Work. Include the following:
 - 1. Fuel Oil pipe routing and size.
 - 2. Exhaust pipe routing and size.
- B. **Manufacturer Seismic Qualification Certification: Submit certification that day tank, engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".**
- C. Qualification Data: For installer and manufacturer.
- D. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 - 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 - 5. Report of sound generation.
 - 6. Report of exhaust emissions showing compliance with applicable regulations.
 - 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- E. Extended Maintenance Offer: Priced service contract for Owner's consideration specified in this Section.
- F. Method of Procedure for Field Quality Control Tests.
- G. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - 2. Operating Instructions with description and illustration of the engine-generator set, engine and generator controls and any other controls and indicators.
 - 3. Parts Books that illustrate and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
 - 4. Preventative Maintenance Instructions on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
 - 5. Routine Test Procedures for all electronic and electrical circuits and for the main AC generator.
 - 6. Troubleshooting Chart covering the complete engine-generator set showing description of trouble, probable cause, and suggested remedy.
 - 7. Wiring Diagrams and Schematics showing function of all electrical components.
- B. Warranty: Special warranty specified in this Section.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every ten of each type and rating installed. Furnish at least three of each type.
 - 2. Indicating Lights: one for every ten of each type and rating installed. Furnish at least one of each type.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
 - 1. Maintenance Proximity: Maintain a service center available on a 24-hour a day, 365 days a year, on-call basis, via a toll-free call center, capable of dispatching training, parts, and emergency maintenance repairs from the Installer's local or regional maintenance facility. Installer's maintenance facility shall have a response period of less than four hours normal travel time from Installer's place of business to Project site from time of notification. Maintain records of each generator set, by serial number, for service purposes.
 - 2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 500 miles of Project site, a service center capable of providing parts and emergency maintenance repairs. Maintain records of each generator, by serial number, for service purposes.

- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
 - 1. Breaker Manufacturer: Manufacturer for generator breaker shall be the same as the manufacturer of other breakers proposed for other portions of the Work.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.
- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 110 requirements for Level 2 emergency power supply system.
- I. Comply with IEEE 43, Recommended Practice for Insulation Testing of Large AC Rotating Machinery
- J. Comply with IEC 34
- K. Comply with UL 2200.
- L. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements.
- M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
 - 1. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.11 PROJECT CONDITIONS

- A. Interruption of Existing Electric Service: Comply with requirements defined in Division 26 Section "Common Work Results for Electrical".
- B. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Outdoor Unit: 5 to 123.6 deg F (Minus 15 to plus 50 deg C).
 - 2. Relative Humidity: 0 to 95 percent.
 - 3. Altitude: Sea level to 603 feet.
- C. Unusual Service Conditions: Engine-generator equipment and installation are required to operate under the following conditions:

1.12 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Division 07 Section "Roof Accessories."

1.13 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of switchgear and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

1.14 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide full inspection and maintenance by skilled employees of manufacturer's designated service organization during the Warranty period, including any special warranty period specified.
 - 1. Include routine preventive maintenance and adjusting as required for proper operation as recommended by manufacturer. Provide number of visits recommended by manufacturer; but no less than semi-annual inspection service.
 - 2. Provide parts and supplies same as those used in the manufacture and installation of the original equipment.
 - 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.
- B. Extended Maintenance Service: Offer for the Owner's consideration and evaluation at the time of Product Data Submittal, a priced inspection, maintenance, testing, and repair contract in compliance with the manufacturer's recommended routine preventive maintenance program.
 - 1. The services offered under this contract shall begin after the completion of the Initial Maintenance Service and Special Warranty Period.
 - 2. The Owner shall have the option of renewing for single or multiple years, up to five years, at the price quoted upon completion of the Warranty period.
 - 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings, Cummins Power Generation, or a comparable product by one of the following:
1. Caterpillar; Engine Division.
 2. Cummins Power Generation.
 3. Kohler Co.; Generator Division – with Detroit Diesel Engine.
 4. MTU Onsite Energy – with Detroit Diesel Engine.

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Comply with EPA Tier emissions requirements of CI NSPS for Stationary Emergency Engine Standards.
- C. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- D. Capacities and Characteristics: Suitable for application in 3-phase, 60-Hz system, unless otherwise indicated.
1. Power Output Ratings: Nominal ratings as indicated.
 2. Nominal System Voltage: As indicated on the Drawings.
 3. Output Connections: Three-phase, three wire.
 4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
 5. Service Application: Standby/Emergency Service.
 6. Power rating shall be based on 130-degree C temperature rise when operated at rated load based on ambient conditions stated in PART 1 – "Project Conditions."
- E. Generator-Set Performance for Sensitive Loads:
1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
 3. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 4. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 5. Sustained Short-Circuit Current: For a single and 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

6. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet generator (PMG) excitation for power source to voltage regulator.
7. Subtransient Reactance: 12 percent.
8. Reverse kVAR Performance: at least 0.15 per unit.
9. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2, Ultra Low Sulfur Diesel.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.
- D. Lubrication System: The following items are mounted on engine or skid:
 1. Filter and Strainer: Replaceable; Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
 4. Bypass Valve: Arranged to continue lubrication in the event of filter clogging. The bypass valve shall be integral with the engine filter base or receptacle.
- E. Engine Fuel System:
 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 - a. Variable displacement type to alter the volume of fuel delivered to the spray nozzles according to load demand.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
 3. Fuel Filtration: Primary and Secondary system.
 - a. Primary fuel filter between the fuel tank and transfer pump to screen large contaminants.
 - b. Fuel/water separator system with isolation valves to protect the fuel system from water damage.
 4. Fuel Cooler: Provide as required for the engine to deliver its maximum horsepower to achieve its rated KW at project conditions. Cooler shall be capable of exchanging heat rejected at full load with the cooling medium, including 10% spare/reserve capacity to accommodate fouling.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity. Compatible with 208V – 3-phase external circuit supplied.
- G. Governor: Electronic speed controller; Adjustable isochronous, with speed sensing.
 1. Speed Adjustment: 0 to 10-percent from no load to full rated load.
 2. Provide magnetic pickup off the engine flywheel ring gear to sense speed.
 3. Provide provisions for remote speed adjustment.
 4. Provide provisions for limiting fuel during start-up, and included capability for actuator compensation adjustment.

5. Provide protections from voltage spikes and reverse. In the event of a DC power loss, the forward acting actuator shall move to the minimum fuel position.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition. Provide expansion Tank when required. Construct expansion tank of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 3. Fan: Driven by multiple belts from engine shaft.
 4. Pumps: Driven by multiple belts from engine shaft. Auxiliary coolant pumps where required for separate circuit after-cooling shall also be engine driven.
 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 6. Isolation Valves: Provide isolation valves on top and bottom of the radiator tank to facilitate radiator and water pump maintenance.
 7. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
 8. Maximum static airflow restriction of the system: <Insert Static Here>inches of water column
 9. Radiator Capacity: Provide radiator to allow full rated operation at 123.6 deg F (50 deg C).
 10. Construction: Totally enclosed radiator and radiator fan assembly. Provision for a duct flange or perforated metal grill to protect the radiator core. The fan, fan drive, and fan belts shall be covered with punched steel guards for personnel protection.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Hockey puck style.
 2. Minimum sound attenuation of 25 dB at 500 Hz.
 3. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall not exceed levels listed in Quality Assurance paragraph in Part 1 of this Section.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Air-Intake After-Cooler: Provide After-cooler for combustion air. Coat After-cooler core air surfaces with a corrosion inhibitor to minimize oxidation.
- L. Starting System: 12-V or 24-V electric as required, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length required. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Include accessories required to support and fasten batteries in place.
7. Battery Heater: Thermostatically controlled heater arranged to maintain battery temperature above 50°F (10°C) and automatically shut off when battery temperature attains 90°F (32°C) regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Heater electrical connection compatible with 120V – 1-phase external circuit supplied.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 2085 fuel oil tank. Features include the following:
 1. Tank level indicator.
 2. Capacity: Fuel for 24 hours continuous operation at 100 percent rated power output at 90% full.
 3. Vandal-resistant fill cap.
 4. Containment Provisions: Comply with requirements of authorities having jurisdiction.
 5. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

2.5 CONTROL AND MONITORING

- A. Panel-mounted control switch(es) marked “run–off–automatic” to perform the following Sequence of Operation:
1. When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set.
 2. When mode-selector switch is switched to the on position, generator set starts.
 3. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Provide the following on the generator instrument panel:
1. AC voltmeter(s) for each phase or a phase selector switch.
 2. AC ammeter(s) for each phase or a phase selector switch.
 3. Frequency meter.
 4. Voltage-adjusting rheostat to allow +5 percent voltage adjustment.
 5. DC voltmeter (alternator battery charging).
 6. Engine-coolant temperature gage.
 7. Engine lubricating-oil pressure gage.
 8. Running-time meter.
 9. Fuel Pressure Gauge
 10. Jacket Water Temperature Gauge
- D. Controls to shut down and lock out the generator under any of the following conditions:
1. Failing to start after specified cranking time
 2. Overspeed
 3. Low lubricating-oil pressure
 4. High engine temperature
 5. High lubricating-oil temperature
 6. Operation of remote manual stop station
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, including but not limited to the following:

Schedule 1

	Indicator Function	Visual	Shutdown	Audible
1.	Overcrank	Y	Y	Y
2.	Low water temperature	Y	NA	Y
3.	High engine temperature pre-alarm	Y	NA	Y
4.	High engine temperature	Y	Y	Y
5.	Low lube oil pressure pre-alarm	Y	NA	Y

	Indicator Function	Visual	Shutdown	Audible
6.	Low lube oil pressure	Y	Y	Y
7.	Overspeed	Y	Y	Y
8.	Low fuel main tank	Y	NA	Y
9.	Low coolant level	Y	Y	Y
10.	EPS supplying load	Y	NA	NA
11.	Control switch not in automatic position	Y	NA	Y
12.	High battery voltage	Y	NA	NA
13.	Low cranking voltage	Y	NA	Y
14.	Low voltage in battery	Y	NA	NA
15.	Battery charger ac failure	Y	NA	NA
16.	Lamp test	Y	NA	NA
17.	Contacts for local and remote common alarm	Y	NA	Y
18.	Audible alarm silencing switch	NA	NA	Y
19.	Low starting air pressure	Y	NA	NA
20.	Low starting hydraulic pressure	Y	NA	NA
21.	Air shutdown damper when used	Y	Y	Y
22.	Remote emergency stop	NA	Y	NA
23.	Fuel tank derangement alarm	Y	NA	Y
24.	Fuel tank high-level fuel supply shutdown alarm	Y	NA	Y
25.	Generator overload	Y	NA	Y
26.	Low fuel secondary tank	Y	NA	Y
27.	Fuel leak main tank	Y	NA	NA
28.	Fuel leak secondary tank	Y	NA	NA
29.	High Alternator temperature	Y	NA	Y
30.	Ground Fault Indication	Y	NA	NA

- F. Individual alarm indication to annunciate any of the conditions listed above with the following characteristics:
 - 1. Battery powered
 - 2. Visually indicated
 - 3. Have a lamp test switch(es) to test the operation of all alarm lamps
 - 4. Controls to shut down the generator upon removal of the initiating signal or manual emergency shutdown
 - 5. Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Provide 4 spare spaces for future alarms. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
- G. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- H. TCP/IP and Modem Cards: Provide TCP/IP and modem cards capable of connecting to owners IP network to communicate faults, alarms and send SMS messages.
- I. Remote Emergency Stop Switch: Push button, "break-glass" type: Flush mounted, two position "break glass" operator. Operator shall be held in a depressed position by a glass disc. When the glass disc is broken by the chain-attached hammer, the button shall return to a normal extended position. Provide a package of five discs with the operator. Provide operator and contact block with one normally open and one normally closed (1NO - 1NC) contact.
- J. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."
- K. Remote Alarm Annunciator (GAP): Comply with NFPA 99 and Schedule 1 above. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
 - 1. Coordination: Coordinate selection of Generator Breaker with other breakers included in other portions of the Work. Refer to Division 26 "Overcurrent Protective Device Coordination Study" for further requirements.
 - 2. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 3. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - 4. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 5. Mounting: Adjacent to or integrated with control and monitoring panel.
 - 6. Locking: Disconnecting means lockable in the open/off position.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Type: Alternating current, synchronous.
- C. Temperature Rise: As indicated in Engine-Generator Set section above.
- D. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- E. Electrical Insulation: Class H.
- F. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- G. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- H. Enclosure: Dripproof.
- I. Instrument Transformers: Mounted within generator enclosure.
- J. Voltage Regulator: Solid-state Microprocessor-based type separate from exciter, providing performance as specified. Control to allow for programmability based on the type of load connected.
 - 1. Adjusting rheostat control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
 - 2. Features:
 - a. Solid state voltage build up: Integrates accessories into one convenient unit.
 - b. No replaceable fuses.
 - c. Over-excitation Protection: Shuts off generator output when excitation current exceeds normal operating currents for 15 seconds or instantaneous shutoff if output is shorted.
 - d. Fault Detection Logging: Diagnostics identifying operation outside of programmed limits, and specific fault information is available even after the unit has been powered down.
 - e. Digital Display: Allows system parameter monitoring.
 - f. Adjustable overvoltage protection.
 - g. Adjustable undervoltage protection.
 - h. Adjustable Underfrequency protection.
 - i. Gain adjustment 0 to 10-percent to provide output voltage compensation for changes in load or frequency.
 - j. Reactive droop control, adjustable 0 to 10% droop at full load and 0.8 PF.
 - k. True RMS 3-phase voltage monitoring.
 - l. Remote communication capability.
 - m. Rotating diode monitor.
 - n. Protection against loss of voltage sensing and long term overcurrent conditions. The overcurrent protection function shall automatically reset when the regulator is de-energized. The regulator shall not be damaged or result in unsafe operation when subjected to open or shorted input due to sensing loss, or a short to ground or adjacent conductor.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

- L. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Weatherproof Sound Attenuated Enclosure Fabrication: Steel, rated for environmental conditions at installed location.
 - 1. Construction: Vandal-resistant, Galvanized-steel, metal-clad enclosure erected on concrete foundation. Instruments and control shall be mounted within enclosure.
 - 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads, adequate to resist loads imposed by sustained winds and 3 second gusts based on the project location Exposure criteria. 50-mph (241-km/h) shall be capable of withstanding a minimum of 165 MPH wind speed gust for three (3) seconds, with Exposure C criteria as per ASCE 7.
 - 3. Muffler Location: Within enclosure. Flat hockey-puck style.
 - 4. Hinged Panels: Allow access to generator, control sections, metering, and accessory compartments. Hinged panels must be arranged for minimum of 120-degree swing; standard 90-degrees swing is not acceptable. Multiple panels shall be lockable and provide adequate access to components requiring maintenance.
 - 5. Ventilation louvers equipped with insect and rodent screen arranged to permit air circulation while excluding insects, rodents, and minimize exterior dust.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
- C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 - 1. Ballasts for Low-Temperature Environments:
 - a. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
 - 2. AC lighting system and connection point for operation when remote source is available.
 - 3. Battery for DC lighting system for operation when remote source and generator are both unavailable as follows:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Bodine Company, The.
 - 2) IOTA Engineering, L.L.C.
 - 3) Side Lite.
 - b. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast. Comply with UL 924.
 - 1) Compatibility: Certified by manufacturer for use with specific lamp type indicated.
 - 2) Emergency Connection: Operate 1 fluorescent lamp(s) continuously at an output of 1100 lumens each, unless otherwise indicated. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 3) Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

- a) Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b) Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- 4) Battery: Sealed, maintenance-free, nickel-cadmium type.
- 5) Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
- D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.
- E. Metal Shroud: Provide metal shroud to force radiator discharge air out through the wall louver and turn up. Provide shroud assembly with gravity type louver in front of the radiator and a drain at the base of the shroud. Finish shroud to match enclosure.
- F. Turning Vane: Provide metal turning vane to force radiator discharge air up vertically. Provide assembly with gravity type louver at in front of the radiator and a drain at the base. Finish turning vane to match enclosure.

2.9 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene or Bridge-bearing neoprene, complying with AASHTO M 251.
 - 2. Durometer Rating: as recommended by the engine manufacturer, unless otherwise indicated.
 - 3. Number of Layers: as recommended by the engine manufacturer, unless otherwise indicated.
- B. Spring Isolators: Freestanding, steel, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Base Plates: Factory drilled for bolting to structure and bonded to 1/4-inch (6-mm) thick, rubber isolator pad attached to underside of base plate. Base Plate shall limit floor load to 500 psig (3447 kPa).
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. **Overload Capacity:** Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

- A. Outdoor Enclosures and Components: Factory-applied finish in manufacturer's standard enamel over corrosion-resistant treatment or rust-inhibiting primer coat, undersurfaces treated with corrosion-resistant undercoating.
 1. Color: Manufacturer's Standard Color or Custom Color to match Architect's Selection (with acceptance of optional price adder)

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 2. Conduct EPA Emissions test in compliance with the TIER Level requirements for the project location.
 3. Full load run (minimum of four hours).
 4. Maximum power.
 5. Voltage regulation.
 6. Transient and steady-state governing.
 7. Single-step load pickup.
 8. Safety shutdown.
 9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to witness and assist with the equipment installations, including connections.

3.3 APPLICATION

- A. Remote Emergency Stop Switch Locations: Provide emergency stop switch in the following locations, unless otherwise indicated:

1. Adjacent Building/Screen Wall near Exterior Generator Enclosure.
 2. Other locations as indicated on the Drawings or required by the AHJ.
- B. Remote Alarm Annunciator Panel (GAP) Locations: Provide annunciator panels in the following locations, unless otherwise indicated:
1. Data Center Control Room.
 2. Central Plant Operations Office.
 3. Building Security Desk.
 4. Other locations as indicated on the Drawings.

3.4 INSTALLATION

- A. Comply with NECA/EGSA 404, "Recommended Practice for Installing Generator Sets" as published by the National Electrical Contractors Association.
- B. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Install and anchor equipment level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
- E. Install packaged engine generator with vibration isolation having a minimum deflection of 1 inch on concrete base.
1. Provide integral vibration isolators and as required for the application and as recommended by the manufacturer elastomeric isolator pads **restrained** spring isolators
 2. Secure engine generator set to anchor bolts installed in concrete bases. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
- G. Provide full fuel tank for generator after completion of all tests.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Connect fuel piping to engines with an indicating-type valve and union and flexible connector.

- E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Connect wiring to remote alarm and annunciator accessories using manufacturers recommended multiconductor wiring method.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- H. Provide connection from TCP/IP car to Owner's IP network.
- I. Provide connection from terminal block to Facility Management System.

3.6 IDENTIFICATION

- A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."
- B. Affix a label with a toll-free telephone number for contacting emergency maintenance field service to front of each generator unit.
- C. Warranty Nameplate: Affix a metal label to the generator that lists the following data:
 - 1. Warranty Period
 - 2. Start up Date
 - 3. Termination Date
 - 4. Supplier Name
 - 5. Supplier Address
 - 6. Preventive maintenance Contract Holder

3.7 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Coordinate tests with tests for transfer switches and run them concurrently.
 - 4. Provide Fuel, oil, and other materials necessary to conduct tests.
 - 5. Provide Load Bank, temporary ventilation, instruments, and other testing materials necessary to conduct tests.
 - 6. Perform Engine-Generator Pre-start Checklist provided by manufacturer, including but not limited to the following items, proceed with startup only after all pre-start checklist items are satisfactory and within manufacturers guidelines.
 - a. Verify that all packing materials have been properly removed.
 - b. Verify proper Oil level.
 - c. Verify proper Water level .
 - d. Verify proper Day tank fuel level, where provided.
 - e. Verify proper Sub-base fuel tank fuel level, where provided.
 - f. Verify Battery connection and charge condition are correct.
 - g. Verify Engine to control interconnects are correct.
 - h. Verify Engine-generator intake air/exhaust openings are not obstructed.
 - i. Verify Engine-generator and enclosure ventilation openings are not obstructed.
- B. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
 2. Inspect generator installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
 3. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
- C. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
1. After installing generator but before equipment is energized, verify that grounding system at generator tests to specified value or better.
 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
 - a. Engine Generator Section, 7.22.1.
 - b. Circuit Breakers, Section 7.3.
 - c. Cables, Section 7.3.
 - d. Ground-fault Systems, Section 7.14.
 - e. Battery Systems, Section 7.18.
 3. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
 - a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each power wiring termination and each bus connection. Open or remove doors and covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. The testing agency in conjunction with the Manufacturer's Field Service shall work with a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Assist factory-authorized service representative during testing and correct deficiencies as required. Report results in writing.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Perform functional and operational sequence testing according to approved Method or Procedure.
 3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to,
 - a. Single-step full-load pickup test.
 - b. Full load test, minimum of four hours.
 4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 9. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
 11. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 12. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 13. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 14. Testing Instruments: Instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- E. Correct Deficiencies, Retest and Report:
1. Report results of tests and inspections in writing.
 2. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations.
 3. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace switches, relays, conductors, units, and devices as required to bring system into compliance.
 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 5. Prepare a report, certified by manufacturer and manufacturer's field service, that identifies component, connection, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.8 ADJUSTING

- A. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.
1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Coordination Study." are completed.
- B. Set field-adjustable intervals and delays, and relays per manufacturer's requirements, unless otherwise indicated.

3.9 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of cover plates inspect interior surfaces and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of covers installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 3. Repair exposed surfaces to match original finish.

3.10 PROTECTION

- A. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."
- B. Coordinate this training with that for transfer switches.

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SECTION 263353

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes a three-phase, on-line, double-conversion, static-type, UPS installation complete with the following features:
1. Transient voltage surge suppression.
 2. Input harmonics reduction.
 3. Rectifier-charger.
 4. Battery.
 5. Battery disconnect device.
 6. Inverter.
 7. Static bypass transfer switch.
 8. Maintenance bypass/isolation switch.
 9. Remote UPS monitoring provisions.
 10. Battery monitoring.
- B. UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM BASIC SYSTEM DESCRIPTION
1. Provide a UPS system for the Data Center to be installed in the Data Center room on the concrete floor in-line with the Owner's switch rack row and adjacent to an in-row cooler. The UPS shall be a modular unit equal to Vertiv Liebert model eXM. An acceptable substitute shall be the Schneider Electric APC Symmetra. The UPS system shall be configured in the following manner:
 - a. UPS cabinet - 24" wide by 48" deep
 - b. Battery cabinet with dc breaker - 24" wide by 48" deep
 - c. Maintenance bypass cabinet - 12" wide by 48" deep; 3-breaker BIB, MBB, MIB with SKRU
 - d. Row line-up left to right facing:
 - 1) (5) switch racks rated at 3 KW each, with two (2) PDU power strips each - (1) connected to UPS/genset power and (1) connected to normal/genset power (all racks and PDU power strips will be provided by Owner but installed and connected by electrical contractor)
 - 2) (1) 24" wide in-row cooler
 - 3) Battery cabinet
 - 4) Maintenance bypass cabinet
 - e. Row line-up left to right opposite facing:
 - 1) (1) 12" wide in-row cooler
 - 2) Server racks 1 & 2 each rated at 6 KW and each with four (4) PDU power strips - (2) connected to UPS/genset power and (2) connected to normal/genset power (all racks and PDU power strips will be provided by Owner but installed and connected by electrical contractor)
 - 3) (1) 12" wide in-row cooler
 - 4) Server racks 3, 4, & 5 each rated at 6 KW and each with four (4) PDU power strips - (2) connected to UPS/genset power and (2) connected to normal/genset power (all will be provided by Owner but installed and connected by electrical contractor)
 - 5) (1) 12" wide in-row cooler
 - 6) Server racks 6 (rated at 6 KW) & 7 (rated at 9 KW) and each with four (4) PDU power strips - (2) connected to UPS/genset power and (2)

connected to normal/genset power (all will be provided by Owner but installed and connected by electrical contractor)

- 7) (1) 12" wide in-row cooler
2. The UPS shall be dual input rated 80 KW / 80 KVA; 208V, 3W+G input; 208V, 3W+G bypass; 208V, 4W+G output. The total Rating of the UPS shall be comprised of four (4) 20 KW modules each consisting of a rectifier/charger, Inverter, and fully rated static switch. Three (3) 20 KW modules (or 60 KW) shall be for capacity and one (1) 20 KW module shall be for redundancy. The battery shall be a VRLA cabinet mounted battery, with backup time maximized in one cabinet. Power wiring and control wiring for the UPS system shall be in separate conduits. The UPS shall be provided with a data gateway to transmit UPS operational, trouble, and alarm data to the FMS. The manufacturer shall provide full start-up services and full functional performance acceptance testing including a 12 hour 100% load burn-in and battery discharge test. Provide full certified test report.
3. The Uninterruptible Power System (UPS) shall be optimized for maximum efficiency and shall automatically maintain AC power to the critical load within specified tolerances and without interruption during failure or deterioration of the normal power source. All UPS materials and equipment shall be fully compatible with electrical, environmental, and space conditions at the site, and shall include all equipment necessary to properly interface the AC power source to the intended load and be designed for unattended operation.
4. The UPS cabinet dimensions shall not exceed: 24" Width x 48" Depth x 80" Height. The battery cabinet dimensions shall not exceed: 24" Width x 48" Depth x 80" Height. The external maintenance bypass may be a stand-alone panelboard containing three (3) circuit breakers: bypass isolation breaker (BIB), maintenance isolation breaker (MIB), and maintenance bypass breaker (MBB); a solenoid key release unit (SKRU) interlock; two (2) 250 amp sub-feed load breakers; and 2A/2B aux contacts and LSI electronic trip on all breakers.
5. The UPS shall be able to supply all required power to full rated output kVA loads with power factor from 0.5 lagging to unity and from unity power factor to 0.5 leading power factors subject to derating.
6. Load voltage and bypass line voltage shall be 208VAC, three-phase, four-wire plus ground. Input voltage shall be 208VAC, three-phase, four-wire plus ground. The AC input source and bypass input source shall each be a solidly grounded wye service.
7. The battery shall support the UPS at 100% rated kW load for at least 7 minutes at 77°F (25°C) at startup.
8. The UPS shall have an active power factor-corrected IGBT converter/rectifier, capable of maintaining input power factor and input current total harmonic distortion (THDi) within specifications without an additional input filter.
9. The UPS shall be of transformer-free design, requiring no internal transformer in the main power path for the basic operation of the module.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. THD: Total harmonic distortion.
- E. UPS: Uninterruptible power supply.
- F. BDC: Bi-Directional AC-to-AC Converter

G. FES: Flywheel Energy Storage

H. MMU: Multi-Module Unit

1.3 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

1.4 ACTION SUBMITTALS

- A. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section "Common Work Results for Electrical".
- B. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- C. Simultaneous Action Submittals: Static Uninterruptible Power Supply Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- D. Product Data: Include data on features, components, ratings, and performance for each UPS component indicated.
1. Detailed installation instructions covering operation under both normal and abnormal conditions.
- E. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
1. Wiring Diagrams: Power, signal, and control wiring.
 2. Assembly and mounting details for all Equipment and shipping splits.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where static uninterruptible power supplies are included in the Work.

- B. **Manufacturer Seismic Qualification Certification:** certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. **Qualification Data:** For Installer, power quality specialist, and manufacturer.
- D. **Manufacturer Certificates:** For each product, signed by manufacturers.
- E. **Source quality-control test reports.**
- F. **Extended Maintenance Offer:** Priced service contract for Owner's consideration specified in this Section.
- G. **Field Quality-Control and Performance Test Reports:** Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

1.6 CLOSEOUT SUBMITTALS

- A. **Operation and Maintenance Data:** For UPS units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
 2. Detailed operating instructions covering operation under both normal and abnormal conditions.
- B. **Warranties:** Special warranties specified in this Section.

1.7 EXTRA MATERIALS

- A. **Furnish extra materials** described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 1. **Fuses:** One for every 10 of each type and rating, but no fewer than 1 of each.
 2. **Cabinet Ventilation Filters:** One complete set.
 3. **Neutralization Kit:** An approved kit for the neutralization of a release of electrolyte. The kit shall be capable of controlling and neutralizing a release of 3 percent of the capacity of the largest battery cell or block in the room to a pH between 7.0 and 9.0.

1.8 QUALITY ASSURANCE

- A. **Installer Qualifications:** Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.
- B. **Power Quality Specialist Qualifications:** A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in Part 3 "Performance Testing" Article.
- C. **Manufacturer Qualifications:** Maintain a service center available on a 24-hour a day, 365 days a year, on-call basis, via a toll-free call center, capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification. Maintain records of each UPS, by serial number, for service purposes.

- D. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS installation.
 - 1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. UL Compliance: Listed and labeled under UL 1778 and UL 1004.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
 - 3. Deliver equipment in fully enclosed vehicles after spaces where equipment is to be placed meets manufacturer's ambient temperature and humidity tolerances for non-operating equipment.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.10 WARRANTY

- A. Special UPS System Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

- ~~B. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.~~

- ~~1. Warranted Cycle Life for Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:~~

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	45 seconds	1.67	120 cycles

2. ~~[Warranted Cycle Life for Premium Valve-Regulated, Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F:~~

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1.5 minutes	1.67	750 cycles

1.11 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide full inspection and maintenance by skilled employees of manufacturer's designated service organization during the Warranty period, including any special warranty period specified.
1. Include routine preventive maintenance and adjusting as required for proper operation as recommended by manufacturer. Provide number of visits recommended by manufacturer; but no less than semi-annual inspection service.
 2. Provide parts and supplies same as those used in the manufacture and installation of the original equipment.
 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.
- B. Extended Maintenance Service: Offer for the Owner's consideration and evaluation at the time of Product Data Submittal, a priced inspection, maintenance, testing, and repair contract in compliance with the manufacturer's recommended routine preventive maintenance program.
1. The services offered under this contract shall begin after the completion of the Initial Maintenance Service and Warranty Period.
 2. The Owner shall have the option of renewing for single or multiple years, up to five years, at the price quoted upon completion of the Warranty period.
 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.

PART 2 - PRODUCTS

2.1 PERFORMANCE DESCRIPTION

- A. Automatic operation includes the following:
1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the output.
 2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.
 3. If normal power fails, energy supplied by the battery continues supply-regulated ac power to the load without switching or disturbance.
 4. When power is restored at the normal supply terminals of the system, controls automatically synchronize with the external source before transferring the load. The

- rectifier-charger then supplies power to the load and simultaneously recharges the battery.
5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
 6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
 7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
 8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
 9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
- B. Manual operation includes the following:
1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
 2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.
- C. Internal and External Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection between the following three conditions without interrupting supply to the load during switching:
1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
 2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
 3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and the UPS rectifier-charger and inverter, or the battery and the inverter.

2.2 SERVICE CONDITIONS

- A. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
1. Ambient Temperature for Electronic Components: 32 to 104 deg F.
 2. Ambient Temperature for Battery: 41 to 95 deg F.
 3. Relative Humidity: 0 to 95 percent, noncondensing.
 4. Altitude: Sea level to 4000 feet.

2.3 PERFORMANCE REQUIREMENTS

- A. The UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
1. Inverter is switched to battery source.
 2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.

3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
 4. THD of input voltage is 10 ~~45~~ percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
 5. Load is 30 ~~[50]~~~~[100]~~ percent unbalanced continuously.
- B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load current at 80 percent power factor, minimum duration of supply is 5 minutes.
 - C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 15 ~~[20]~~~~[30]~~ percent from nominal voltage.
 - D. Overall UPS Efficiency: Equal to or greater than 94 percent at 100 percent load, 95 percent at 75 percent load, and 95 percent at 50 percent load.
 - E. Maximum Acoustical Noise: Maximum 60 dBA, emanating from any UPS component under any condition of normal operation, measured 48 inches from nearest surface of component enclosure, unless otherwise indicated.
 - F. Maximum Energizing Inrush Current: Eight times the full-load current.
 - G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
 - H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
 - I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
 1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 or 10 percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
 - J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
 - K. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
 - L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
 1. 50 Percent: Plus or minus 5 percent.
 2. 100 Percent: Plus or minus 5 percent.
 3. Loss of AC Input Power: Plus or minus 1 percent.
 4. Restoration of AC Input Power: Plus or minus 1 percent.
 - M. Input Power Factor: A minimum of 0.85 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
 - N. EMI Emissions: Comply with FCC Rules and Regulations, and with 47 CFR 15 for Class A equipment.

2.4 UPS SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings, Liebert eXM; a division of Vertiv as base bid. Provide alternate pricing in accordance with Division 01 Section "Alternates" for a comparable product by one of the following:
 - 1. APC; a division of Schneider Electric
 - 2. Powerware; a division of Eaton
- B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
- C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
- D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
- E. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.
 - 1. Use factory-installed surge suppressors tested according to IEEE C62.41, Category B.
 - 2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.
- F. Maintainability Features: Rectifier-charger and inverter sections and the static bypass transfer switch shall be modular plug-ins, readily accessible for maintenance.
- G. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future increase in UPS capacity. Refer to UPS system description hereinbefore.
- H. Seismic-Restraint Design: UPS assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them), shall be designed and fabricated to withstand static and seismic forces.
- I. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.
- J. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.5 STATIC DISCONNECT SWITCH

- A. Description: Continuous duty rated, phase controlled, full wave, three-phase, line-commutated electronic switch using SCRs as switching devices. Each phase protected by fast-acting fuses. Isolated from the input by a contactor.

- B. Operation: The switch shall turn off within one-half cycle of detecting an input voltage or frequency outside of preset limits as specified. Phasing of the switch shall also inhibit reverse power flow from the output of the switch to the input. Connection to the AC input through the switch shall be initiated when the phase difference between the input and output is less than one-half degree to reduce inrush currents when reconnecting to input power after a discharge.

2.6 RECTIFIER-CHARGER

- A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
- C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
 - 1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
- D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.7 INVERTER

- A. Description: Insulated gate bi-polar transistor (IGBT), Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.8 STATIC BYPASS TRANSFER SWITCH

- A. Description: Solid-state switching device providing uninterrupted transfer. A contactor automatically provides electrical isolation for the switch.
- B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.9 BATTERY

- A. Description: Valve-regulated, premium, heavy-duty, recombinant, lead-acid units, factory assembled in a separate matching cabinet, complete with battery disconnect switch. The selection of the battery shall be such that it is regularly matched with the specified UPS.
 - 1. Arrange for drawout removal of battery assembly from cabinet for testing and inspecting.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C&D Technologies, Inc.
 - b. Eaton Corporation; Powerware Division.
 - c. EnerSys, Inc.
 - d. Exide Technologies
 - e. HOPPECKE.
 - f. Panasonic Corporation of North America; Panasonic Industrial Company.
 - g. SAFT.

- C. **Seismic-Restraint Design:** Battery racks, cabinets, assemblies, subassemblies, and components (and fastenings and supports, mounting, and anchorage devices for them), shall be designed and fabricated to withstand static and seismic forces.

2.10 CONTROLS AND INDICATIONS

- A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
- B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
- C. Indications: Plain-language messages on a digital LCD or LED. Not all of these points may be available. Define what is available in the submittal.
1. Quantitative indications shall include the following:
 - a. Input voltage, each phase, line to line.
 - b. Input current, each phase, line to line.
 - c. Bypass input voltage, each phase, line to line.
 - d. Bypass input frequency.
 - e. System output voltage, each phase, line to line.
 - f. System output current, each phase.
 - g. System output frequency.
 - h. Elapsed time discharging battery.
 - i. System output power factor.
 - j. System output apparent power in kVA.
 - k. System output real power in kW.
 - l. DC bus voltage.
 - m. Battery current and direction (charge/discharge).
 2. Basic status condition indications shall include the following:
 - a. Normal operation.
 - b. Load-on bypass.
 - c. Inverter off.
 - d. Alarm condition.
 - e. Load-on battery.
 3. Alarm indications shall include the following:
 - a. Bypass ac input overvoltage or undervoltage.
 - b. Bypass ac input overfrequency or underfrequency.
 - c. Bypass ac input and inverter out of synchronization.
 - d. Bypass ac input wrong-phase rotation.
 - e. Bypass ac input single-phase condition.
 - f. Bypass ac input filter fuse blown.
 - g. Internal frequency standard in use.
 - h. Control power failure.
 - i. Fan failure.
 - j. UPS overload.
 - k. Input overvoltage or undervoltage.
 - l. Input transformer overtemperature.
 - m. Input circuit breaker tripped.
 - n. Input wrong-phase rotation.
 - o. Input single-phase condition.
 - p. Static bypass transfer switch over temperature.
 - q. UPS overload shutdown.
 - r. Inverter current sensor fault.
 - s. Inverter output contactor open.

- t. Inverter current limit.
- u. Identification of faulty inverter section/leg.
- v. Inverter fuse blown.
- w. Inverter transformer overtemperature.
- x. Inverter overtemperature.
- y. Inverter output overvoltage or undervoltage.
- z. Inverter power supply fault.
- aa. Inverter transistors out of saturation.
- bb. Battery system alarm.
- cc. Battery undervoltage shutdown.
- dd. Maximum battery voltage.
- ee. Approaching end of battery operation.
- ff. Battery-charging control faulty.
- 4. Controls shall include the following:
 - a. UPS start.
 - b. Alarm silence/reset.
 - c. Output-voltage adjustment.
 - d. Inverter on-off.
 - e. Battery test.
- D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
 - 1. UPS on-line.
 - 2. UPS load-on bypass.
 - 3. UPS in alarm condition.
 - 4. UPS off (maintenance bypass closed).
 - 5. UPS on battery.
- E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.11 MAINTENANCE BYPASS/ISOLATION SWITCH

- A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
 - 1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
 - 2. Switch shall electrically isolate other UPS components to permit safe servicing.
- B. Comply with NEMA PB 2 and UL 891.
- C. Switch Rating: Continuous duty at rated full UPS load current.
- D. Mounting Provisions: Internal to system cabinet.
- E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.12 MONITORING BY REMOTE STATUS AND ALARM PANEL

- A. Description: Labeled LEDs on panel faceplate indicate basic status conditions. Audible signal indicates alarm conditions. Silencing switch in face of panel silences signal without altering visual indication.

1. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.

2.13 CAPABILITY OF MONITORING BY REMOTE COMPUTER

- A. Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:
 1. Connectors and network interface units or modems for data transmission via RS-232 link.
 2. Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Design for windows applications using a personal computer, which is not included in this Section.

2.14 BASIC BATTERY MONITORING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Albercorp; Hawker Siddeley.
 2. BTECH Inc.
 3. MetriXX USA, Inc.
 4. NDSL Group Ltd.
 5. Powerware; an Invensys Company.
- B. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.
- C. Annunciation of Alarms: At UPS control panel.

2.15 BATTERY-CYCLE WARRANTY MONITORING

- A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.
- B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.
- C. Additional monitoring functions and features shall include the following:
 1. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
 2. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
 3. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
 4. Alarm Contacts: Arranged to initiate alarm for battery discharge events, abnormal temperature, and abnormal battery voltage or temperature.
 5. Memory: Stores recorded data in nonvolatile electronic memory.
 6. RS-232 Port: Permits downloading of data to a portable personal computer.
 7. Modem: Makes measurements and recorded data accessible to remote personal computer via telephone line. Computer is not specified in this Section.

2.16 SOURCE QUALITY CONTROL

- A. Factory test complete UPS system before shipment. Use simulated battery testing. Include the following:
 - 1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 - 2. Full-load test.
 - 3. Transient-load response test.
 - 4. Overload test.
 - 5. Power failure test.
- B. Report test results. Include the following data:
 - 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
 - 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
 - 3. List of instruments and equipment used in factory tests.

2.17 ACCESSORY COMPONENTS AND FEATURES

- A. TCP/IP Capability: Provide TCP/IP capable of connecting to owners IP network to communicate faults, alarms and send SMS messages.
- B. Connection to Data Link Capability: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 411, "Standard for Installing and Maintaining Uninterruptible Power Supplies (UPS)" as published by the National Electrical Contractors Association and adopted by ANSI.
- B. Install and anchor equipment level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.2 GROUNDING

- A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.3 CONNECTIONS

- A. Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

- B. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of UPS remote alarm panels as recommended by manufacturer. Provide raceway sizes necessary to accommodate required wiring.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- E. Provide connection capability from TCP/IP card to Owner's IP network.
- F. Provide connection capability from terminal block to Facility Management System.

3.4 IDENTIFICATION

- A. Identify components and wiring according to Division 26 Section "Identification for Electrical Systems."

3.5 BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
 3. Assist in field testing of equipment including pre-testing and adjusting of equipment and components.
- B. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications Section 7.18 and 7.22.2. Certify compliance with test parameters.
 3. Test manual and automatic operational features and system protective and alarm functions.
 4. Verify that UPS is installed and connected according to the Contract Documents.
 5. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
 6. Complete installation and startup checks according to manufacturer's written instructions.
 7. Test communication of status and alarms to remote monitoring equipment.
 8. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated, within the previous six months according to NIST standards.
 - a. Simulate malfunctions to verify protective device operation.
 - b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.

- c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
 - d. Test output voltage under specified transient-load conditions.
 - e. Test efficiency at 50, 75, and 100 percent of rated loads.
 - f. Test remote status and alarm panel functions.
- Test battery-monitoring system functions.
- C. The testing agency shall work in conjunction with the Manufacturer's Field Service shall work with a factory-authorized service representative to perform the start-up, field tests and inspections and prepare certified test reports.
- D. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 - 1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications Section 7.18 and 7.22.2. Certify compliance with test parameters.
 - 3. Test manual and automatic operational features and system protective and alarm functions.
 - 4. Verify that UPS is installed and connected according to the Contract Documents.
 - 5. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
 - 6. Complete installation and startup checks according to manufacturer's written instructions.
 - 7. Test communication of status and alarms to remote monitoring equipment.
 - 8. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated, within the previous six months according to NIST standards.
 - a. Simulate malfunctions to verify protective device operation.
 - b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
 - c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
 - d. Test output voltage under specified transient-load conditions.
 - e. Test efficiency at 50, 75, and 100 percent of rated loads.
 - f. Test remote status and alarm panel functions.
 - g. Test battery-monitoring system functions.
- E. Seismic-restraint tests and inspections shall include the following:
 - 1. Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
 - 2. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. Correct Deficiencies, Retest and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace units and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a report, certified by testing agency, that identifies unit components and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

- G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.7 ADJUSTING

- A. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.
 - 1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Coordination Study." are completed.

3.8 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 3. Repair exposed surfaces to match original finish.

3.9 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain the UPS. Refer to Division 01 Section "Demonstration and Training."

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SECTION 263600

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Bypass/isolation switches.
 - 3. Remote annunciation systems.
- B. Automatic Transfer Switches (ATS) Basic Description
 - 1. Provide automatic transfer switches as follows:
 - a. ATS-1 – 260A / 4-pole, open transition:
 - 1) Emergency egress and exit lighting
 - 2) Genset auxiliary loads
 - 3) Elevators
 - 4) Smoke exhaust fans
 - 5) AHU-1 supply air fans-1,2,3,4 (primary set of supply air fans for smoke exhaust system)
 - b. ATS-2 – 100A / 3-pole, delayed transition:
 - 1) AHU-1 supply air fans-5,6,7,8 (redundant set of supply air fans for smoke exhaust system)
 - c. ATS-3-NDC - 200A / 4-pole, delayed transition:
 - 1) Redundant normal power source for data center UPS loads
 - 2) Redundant cooling for data center cooling
 - d. ATS(BPS)-4-UDC (includes bypass isolation switch) – 200A / 4-pole, delayed transition:
 - 1) Data Center UPS
 - 2) Data Center Cooling
 - e. ATS-FP (by fire protection contractor)
 - 2. ATS's shall be rated for 480Y/277V, 3-pole no neutral or 4-pole with switched neutral, open transition (OT) or delayed transition (DT) transfer switching as indicated above.
 - 3. ATS's shall be equal to ASCO 7000 series or comparable switch provided by Russelectric, GE Zenith, Cummins, or Kohler.
 - 4. ATS's shall be UL1008 with standard NEMA Type 1 enclosure.
 - 5. The ATS shall be provided with a data gateway to transmit ATS operational, trouble, and alarm data to the FMS.
 - 6. The manufacturer shall provide full start-up services and full functional performance acceptance testing with a 12 hour 100% load burn-in and final pull-the-plug system test. Provide full certified test report.
 - 7. ATS's shall be rated for standard 3 to 18-cycle WCR.
 - 8. ATS's shall include a programmable controller with keypad and LCD display. Controller shall display ATS & BPS switch position indicating lights, typical time delays for engine start, transfer, and retransfer, voltage and frequency sensing, and power meter data including volts, amps, freq, pf, kw, kva, kvar. Include aux contacts, 2 closed in normal and 2 closed in emergency. The bypass isolation switch shall be drawout design allowing for bypass without load interruption. ATS and BPS shall have identical electrical ratings.

9. The manufacturer shall provide full start-up services and full functional performance acceptance TESTING IN COORDINATION WITH Generator testing and a final pull-the-plug system test. Provide full certified test report.

C. Related Sections include the following:

1. Transfer Switches for Fire Pumps are specified in Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.

1.2 PERFORMANCE REQUIREMENTS

- A. Overcurrent Protective Device Coordination: All overcurrent protective devices proposed for inclusion in the Work shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of [normal and] emergency power. [Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

B. Sequence of Operation for Automatic Transfer

1. Loss of Normal Source:

- a. After an adjustable time delay period of 0-10 seconds (default setting of 1 seconds), the Engine starting contacts shall close to initiate the starting of the standby engine-generator set when any of the following occur:
 - 1) Voltage on any phase of the normal source drops below 80-percent of nominal or increases to 120-percent of nominal.
 - 2) Frequency drops below 90-percent of nominal or increases to 110-percent of nominal.
 - 3) Voltage differential between phases is greater than 20-percent.

- b. When the emergency source has reached a voltage value of 90-percent of nominal and achieved frequency within 95-percent of the rated value, the load shall be transferred to the emergency source based on the following:

1) Delayed Transition Switches:

- a) When the emergency source has reached the values listed above, the load shall be transferred to the neutral position for an adjustable time period of 0-10 seconds. Upon completion of this neutral time delay the switch shall be transferred to the emergency source.

2) Closed Transition Switches:

- a) When the emergency source has reached the values listed above, the load shall be transferred to the emergency source without delay.

2. Restoration of Normal Source:

- a. Upon restoration of normal power source on all phases to a preset value of 90-percent to 110-percent of rated voltage, 95-percent to 105-percent of rated frequency, and below 20-percent, voltage differential, the switch shall retransfer to the normal source based on the following:

1) Delayed Transition Switches:

- a) When the normal source has been restored to the values listed above, and the time delay transfer to normal has expired, the load shall be retransferred to the neutral position for an adjustable time period of 0-10 seconds. After which the switch shall be connected to the normal source.

2) Closed Transition Switches:

- a) When the normal source has been restored to the values listed above, load shall synchronize and be retransferred to the normal source without delay.
 - b. After retransfer to normal, the generator set shall be allowed to operate at no load for an adjustable period of 0-10 minutes (default setting at 5 minutes). The generator shall run unloaded for this time period and then automatically shut down. The generator shall be ready for automatic operation upon the next failure of the normal source.
- 3. Special Conditions and Failure Modes:
 - a. If the engine generator should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of proper voltage (90-percent) on the normal source.
 - b. [Bypass-isolation Switch: Switch shall be equipped with an independent engine start circuit. Should a utility outage occur while operating the bypass in normal or isolated modes, the engine will automatically start and allow immediate selection to emergency bypass.

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Simultaneous Action Submittals: Transfer Switch Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section "Overcurrent Protective Device Coordination Study." The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.
- C. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
 - 1. Indicate whether the transfer switch withstand and closing rating is based on "Three-Cycle Testing" or "specific coordinated circuit breaker".
 - a. Where a specific circuit breaker rating is used, the submittal data shall include information supporting the actual "coordinated" rating. Include the withstand and closing rating chart showing the transfer switches respective rating with the specific circuit breaker included in the Work to which the transfer switch is being connected to for this project. Coordinate this with the electrical power distribution equipment manufacturer to determine the actual circuit breaker proposed for inclusion in the Work and submit in conjunction with associated power distribution equipment.
- D. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 2. Control schematics and wiring diagrams.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical" for each location where transfer switches are included in the Work.
- B. **Manufacturer Seismic Qualification Certification: Submit certification that transfer switches, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".**
- C. Source quality-control test reports.
- D. Extended Maintenance Offer: Priced service contract for Owner's consideration specified in this Section.
- E. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electrical equipment, accessories and components to be included in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's routine maintenance requirements for transfer switch and all installed components.
 - 2. Features and operating sequences, both automatic and manual.
 - 3. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
 - 4. Manufacturer's written instructions for testing and adjusting device settings.
 - 5. Manufacturer's sample system checklists and log sheets.
 - 6. Manufacturer's written instructions for sequence of operation.
- B. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- B. Manufacturer Qualifications: Maintain a service center available on a 24-hour a day, 365 days a year, on-call basis, via a toll-free call center, capable of providing training, parts, and emergency maintenance repairs within a response period of less than [eight] hours from time of notification. Maintain records of each transfer switch, by serial number, for service purposes.
- C. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, remote annunciators through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.

- G. Comply with NFPA 110.
- H. Comply with UL 1008, unless requirements of these Specifications are stricter.
 - 1. During the UL 1008 withstand and closing tests, there shall be no contact welding or damage.
 - 2. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases.
 - 3. The tests shall be performed without the use of current limiting fuses.
 - 4. Where switch is coordinated with current limiting fuses, the switch shall have withstand and closing current ratings of 200,000 amperes at 480V. Use of current limiting fuses in coordination with a switch is only acceptable if specifically designed as such and indicated on the Drawings.
 - 5. Where switch is coordinated with current limiting circuit breakers, the switch shall have greater withstand and closing current ratings, from 85,000 amperes to 200,000 amperes at 480V, depending on switch size. Use of current limiting circuit breakers in coordination with a switch is only acceptable if specifically designed as such and indicated on the Drawings.
 - 6. Where conducting temperature rise tests to UL-1008, include post-endurance temperature rise tests to verify the ability of the transfer switches to carry full rated current after completing the overload and endurance tests.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Prepare equipment for shipment.
 - 1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.
 - 1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - 2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - a. Ambient Temperature for Micro-Processor Based controls: Not less than 68 deg F and not exceeding 104 deg F.
 - b. Ambient Humidity for Micro-Processor Based controls: Zero percent to 99 percent relative humidity, non-condensing.
 - c. Altitude: Not exceeding 6600 feet.

1.9 COORDINATION

- A. Coordinate layout and installation of transfer switches and components with other construction that penetrates walls or is supported by them, including but not limited to electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases for floor mounted units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of wall-mounting supports with actual transfer switches provided.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of switchgear and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

1.11 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide full inspection and maintenance by skilled employees of manufacturer's designated service organization during the Warranty period, including any special warranty period specified.
 - 1. Include routine preventive maintenance and adjusting as required for proper operation as recommended by manufacturer. Provide number of visits recommended by manufacturer; but no less than semi-annual inspection service.
 - 2. Provide parts and supplies same as those used in the manufacture and installation of the original equipment.
 - 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.
- B. Extended Maintenance Service: Offer for the Owner's consideration and evaluation at the time of Product Data Submittal, a priced inspection, maintenance, testing, and repair contract in compliance with the manufacturer's recommended routine preventive maintenance program.
 - 1. The services offered under this contract shall begin after the completion of the Initial Maintenance Service and Special Warranty Period.
 - 2. The Owner shall have the option of renewing for single or multiple years, up to five years, at the price quoted upon completion of the Warranty period.
 - 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings, ASCO, or a comparable product by one of the following:
 - 1. Contactor Transfer Switches:
 - a. Caterpillar; Engine Div; Series CTS / CBTS.
 - b. ASCO Power Technologies, LP; Series 7000.
 - c. GE Zenith Controls; Series ZTS / ZBTS.
 - d. Kohler Power Systems; Generator Division.

- e. Cummins Power Generation; Industrial Business Group; Series OTPC / BTPC.
- f. Russelectric, Inc; Series RTS.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C and 0 to 99 percent relative humidity, non-condensing.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1. Micro-Processor capable of withstanding surges in accordance with ANSI/IEEE C-37.90A
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- H. Lugs: Mechanical style one or two hole style to suit conditions, suitable for quantity and size of conductor, dual rated for use with copper- or aluminum conductors; UL 486 B listed, marked [AL7CU for 75 degrees C rated circuits] [and] [AL9CU for 90 degrees C rated circuits].
- I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at

terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as required to meet field conditions.
3. Control Wiring:
 - a. Equipped with lugs suitable for connection to terminal strips.
 - b. Wire auxiliary contacts to terminal strips.

2.3 ENCLOSURES

- A. NEMA ICS 6 and UL 508 to meet environmental conditions of installed location as follows, unless otherwise indicated:
 1. Indoor Locations: NEMA 250, Type 1.

2.4 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- C. Signal-Before-Transfer Contacts: Provide ATS's with two sets of normally open/normally closed dry contacts to operate in advance of retransfer to normal source. Interval is adjustable from 1 to 300 seconds.
- D. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- E. Automatic Delayed-Transition Transfer Switches using Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- F. Automatic Transfer-Switch Features:
 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. (Factory set for pickup at 90 percent and dropout at 85 percent.)
 2. Overvoltage Sensing for Each Phase of Normal Source: Sense high phase-to-ground voltage on each phase. Pickup shall be adjustable from 110 to 120 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. (Factory set for pickup at 120 percent and dropout at 110 percent.)
 3. Under-frequency Sensing of Normal Source: Sense low frequency. Pickup frequency shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. (Factory set for pickup at 95 percent and dropout at 90 percent.)
 4. Over-frequency Sensing of Normal Source: Sense high frequency. Pickup frequency shall be adjustable from 105 to 120 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. (Factory set for pickup at 110 percent and dropout at 105 percent.)

5. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
6. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. (Factory set for pickup at 95 percent.)
7. Commit/No-Commit Option: Selectable setting to select either "commit" or "no commit" to transfer operation in the event of a normal power failure.
 - a. In the "commit" position the load will transfer to the emergency source after any normal power failure.
 - b. In the "no commit" position, the load will transfer to the emergency position unless normal power returns before the emergency source has reach 90-percent of it's rated values (switch will remain in normal).
8. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
9. Local Test Switch: Simulate normal-source failure.
10. Switch-Position Pilot Lights: Indicate source to which load is connected.
11. Source-Available Indicating Lights: Supervise sources via transfer-switch normal-and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
12. Unassigned Auxiliary Contacts: Two sets of normally open/normally closed dry contacts, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
13. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
14. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
15. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
16. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.
17. Load Shed Function: Provide load shed function to disconnect the load from the emergency source under the following conditions:
 - a. Overload
 - b. Fire Pump activation: Retransfer to the emergency source upon the fire pump disengagement.

2.5 BYPASS/ISOLATION SWITCHES

- A. Comply with requirements for Level 1 equipment according to NFPA 110.
- B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
 - 1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
 - 2. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
 - 3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
 - 4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
 - 5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
 - 6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
 - 7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
 - 8. No Load Break: Switch constructed so load bypass and transfer-switch isolation can be performed without interruption to load.
- C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.6 REMOTE ANNUNCIATOR SYSTEM

- A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:
 - 1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - 2. Switch position.
 - 3. Switch in test mode.
 - 4. Failure of communication link.
 - 5. Switch in Manual/Override.
- B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
 - 1. Indicating Lights: Grouped for each transfer switch monitored.
 - 2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
 - 3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
 - 4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.7 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1. Submit written test results.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. ~~TCP/IP and Modem Cards:~~ Provide TCP/IP and modem cards] capable of connecting to owners IP network to communicate faults, alarms and send SMS messages.
- B. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. ~~Data system connections to terminals are covered in Division 26 Section "Electrical Power Monitoring and Control."~~
- C. Metering Provisions
 - 1. Requirements:
 - a. Factory installed metering class current transformers (CTs) mounted on each phase of the ATS load-side terminals, wired to a CT shorting block.
 - b. Factory installed meter voltage taps on each phase of the ATS load-side terminal with a properly sized fused block and isolation switch.
- A. Status Contacts: Provide each ATS with normally open/normally closed dry contacts for the following:
 - 1. ATS "Normal" switch position.
 - 2. ATS "Emergency" switch position.
 - 3. ATS "Test Active".

PART 3 - EXECUTION

3.1 APPLICATION

- A. Transfer switch mounting:
 - 1. 1000 Amp or less: Wall mounted, unless otherwise indicated.
 - 2. Over 1000 Amp: Floor mounted, unless otherwise indicated.
- B. Transfer/Bypass Switch mounting:
 - 1. In most cases no matter what amperage size – floor mounted.
- C. Remote Annunciator Panel (ATSAP) Locations: Provide annunciator panels in the following locations, unless otherwise indicated:
 - 1. Data Center Control Room
 - 2. Central Plant Operations Office
 - 3. Building Security Desk

3.2 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details per Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Floor Mounted Switch: Install and anchor equipment level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
- C. Wall-Mounting Switch: Install level.
 - 1. Wall mounted units shall utilize appropriate hardware based on the weight of the unit and installation location.

- D. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

3.3 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Connect start signal and other necessary wiring to Engine Generator control system; coordinate requirements with [Division 26 Section "Engine Generators". Each Automatic transfer switch shall have dedicated control wiring homerun to generator start control. Do not 'daisy-chain' control wiring between switches.
- C. Connect relay wiring to Elevator controller; coordinate requirements with Division 14 "Conveying Equipment."
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- F. Provide capability of connection from TCP/IP card to Owner's IP network.
- G. Provide capability of connection from terminal block to Facility Management System.

3.4 IDENTIFICATION

- A. Identify components according to Division 26 Section "Identification for Electrical Systems."
- B. Affix a label with a toll-free telephone number for contacting emergency maintenance field service to front of each switch.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each transfer switch bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. The testing agency in conjunction with manufacturer's field service shall work with a factory-authorized service representative to perform start-up, load bank and field tests and inspections and prepare certified test reports:
- C. Testing Agency: Engage a qualified independent testing and inspecting agency as defined in Division 26 Section "Common Work Results for Electrical" to perform the following field tests and inspections and prepare certified test reports:
 - 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test, visual and mechanical inspection, and operational test stated in NETA ATS, Sections 7.22.3 as appropriate. Certify compliance with test parameters.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test

voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

- a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- a. Verify grounding connections and locations and ratings of sensors.
6. Record adjustable relay settings and measured insulation and contact resistances and time delays.
7. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
- a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each switch. Open or remove doors and covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Correct Deficiencies and Report:
1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace switches, relays, conductors, units, and devices as required to bring system into compliance.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Prepare a report, certified by testing agency, that identifies switch, connection, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.6 ADJUSTING

- A. Set field-adjustable intervals and delays, relays, and engine exerciser clock. Set delays as indicated below.

ATS Name	Priority Level	Load Shed Function	Time Delay Transfer to Emergency (Sec)	Time Delay Retransfer to Normal Power (Sec)
ATS-1	1	NO	0	300
ATS-2	2	NO	5	360
ATS-3-NDC	4	YES	15	480
ATS(BPS)-4-UDC	3	NO	10	420

3.7 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
1. Remove paint splatters and other spots.
 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
1. Remove paint splatters and other spots.
 2. Remove all temporary markings and labels.
 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 4. Repair exposed surfaces to match original finish.

3.8 PROTECTION

- A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.
- B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."
- B. Coordinate this training with that for generator equipment.

END OF SECTION

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SECTION 264113

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes lightning protection for buildings and building site components including, but not limited to outdoor generator-set enclosures.
- B. Related Sections include the following:
 - 1. Division 26 Section "Grounding and Bonding for Electrical Systems" for common grounding and bonding.

1.2 DEFINITIONS

- A. LPI: Lightning Protection Institute.
- B. NRTL: National recognized testing laboratory.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design lightning protection, including comprehensive engineering analysis by a UL certified company, using performance requirements and design criteria indicated.
- B. Design lightning protection components and systems to meet the requirements of UL 96A, NFPA 780 and LPI 175.

1.4 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For air terminals, conductors, and mounting accessories.
- C. Delegated-Design Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing, conductor connections, and bonding and grounding provisions. In addition also Include the following on shop drawings:
 - 1. Type, material, and size of conductors.
 - 2. Indications for where raceways will be used.
 - 3. Data on how concealment requirements will be met,
 - 4. Calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
 - 5. Installation details for thru roof penetrations.
 - 6. Installation details for conductor connections.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.
- B. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material where air terminals are mounted on single-ply membrane roofing.
- C. Field inspection reports indicating compliance with specified requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lightning protection system, to include in emergency, operation, and maintenance manuals. Provide items specified in Division 01 Section "Operation and Maintenance Data."
- B. Label and Certification: LPI System Certification, a written guarantee of UL compliance, and subsequent issuance of the UL Certificate of Inspection with surge verification.

1.7 QUALITY ASSURANCE

- A. Designer and Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer.
- B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.8 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Lightning Technology, Ltd.
 - 2. Automatic Lightning Protection.
 - 3. East Coast Lightning Equipment, Inc.
 - 4. ERICO International Corporation.
 - 5. Harger Lightning Protection, Inc.
 - 6. Heary Bros. Lightning Protection Co. Inc.
 - 7. Independent Protection Co.
 - 8. Robbins Lightning Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96.
- B. Classification of Lightning Protection Equipment: Provide components in accordance with reference standards.
 - 1. For Roof Levels 75 feet and below in height: Provide NFPA Class I or II components, as required.
 - 2. For Roof Levels greater than 75 feet in height: Provide NFPA Class II components.
- C. Roof-Mounting Air Terminals: Solid Aluminum or Copper, as required by standards and dictated by construction materials to which lightning protection systems components are attached.
- D. Conductors: Stranded Aluminum or Copper, as required by standards and dictated by construction materials to which lightning protection systems components are attached.
 - 1. Provide copper down lead conductors even when aluminum is required at roof level. Extend Copper down lead conductors to roof. Provide approved bi-metallic connector at the thru-roof assembly to transition between aluminum and copper.
- E. Roof Attachment Components: Coordinate installation of roof-attachment components and roof penetrations with roofing installer. Refer to items specified in Division 07 Sections for roofing materials specified and other roof accessories.
 - 1. Provide specialty membrane patches, pads, pavers or other specialty items as required by the roofing manufacturer.
 - 2. Single-Membrane, Roof-Mounting Air Terminals: Where single membrane roofs are specified, provide products designed for single-membrane roof materials.
- F. Mounting Hardware: Stainless steel.
- G. Stack-Mounting Air Terminals: Stainless steel.
- H. Below Grade Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.
- I. Above Grade Cable Connections: Use approved bolted connections for all conductor splices and connections between conductors and other components. Pressure squeeze clamps are not acceptable.
- J. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section "Grounding and Bonding for Electrical Systems" and with standards referenced in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- C. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

- D. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view from exterior locations at grade within 200 feet of building.
 - 5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.
- F. For building in excess of 60 feet (18 m) Tall: Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. UL Inspection: Provide inspections as required to obtain a UL Certificate of Inspection for system.
- B. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION

SECTION 264300

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Surge Protective Devices for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for devices with integral SPD's.

1.2 DEFINITIONS

- A. SPD: Surge Protective Device.
- B. VPR: Voltage Protection Rating.

1.3 ACTION SUBMITTALS

- A. Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section "Common Work Results for Electrical".
- B. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- C. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- D. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:
 - 1. UL 1283.
 - 2. UL 1449.
 - 3. MIL-STD 220A. Conduct spectrum analysis of each unit based on test procedures between 50kHz and 200kHz indicating the device noise attenuation.
 - 4. ANSI/IEEE C62.41.2 and ANSI/IEEE C62.45: Provide certified documentation of applicable Location Category Testing in full compliance guidelines.
- E. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data.
 - 1. Include electrical characteristics and ratings for the specified equipment.
 - 2. Include wiring diagrams indicating the internal connections of the specified equipment within its enclosure.
 - 3. Indicate device dimensions, weights, mounting provisions, and connection details.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports, including the following:
 - 1. Test procedures used.

2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals. Provide items specified in Division 01 Section "Operation and Maintenance Data."
- B. Warranties: Special warranties specified in this Section.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Replaceable Protection Modules: One Twoof each size and type installed.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For independent agency as defined in Division 26 Section "Common Work Results for Electrical".
- B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
 1. Exception: Factory-installed devices specified in other Division 26 Sections are not required to match externally mounted units.
- C. Product Options: Drawings indicate size, spatial requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Safety for Surge Protective Devices."

1.8 PROJECT CONDITIONS

- A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 2. Operating Temperature: 30 to 120 deg F
 3. Storage Temperature: -40 to 185 deg F (-40 to 85 deg C)
 4. Operating Frequency: 47 to 63 Hertz.
 5. Humidity: 0 to 85 percent, noncondensing
 6. Altitude: Less than 12,000 feet above sea level.

1.9 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.
- B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ACT Communications, Inc.
 - 2. Current Technology, Inc.
 - 3. General Electric Co.; Electrical Distribution & Protection Div.
 - 4. LEA International.
 - 5. Leviton Mfg. Company Inc.
 - 6. Liebert Corporation; a division of Emerson.
 - 7. Siemens Energy & Automation, Inc.
 - 8. Square D; Schneider Electric.
 - 9. United Power Corporation.
 - 10. Surge Suppression, Inc.
 - 11. Others as approved.

2.2 COMMON REQUIREMENTS FOR SUPPRESSORS

- A. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity. SCCR rating of the SPD shall be 200kAIC without the need for upstream overcurrent protection.
 - 2. Fabrication using bolted compression lugs for internal wiring.
 - 3. Redundant suppression circuits.
 - 4. Redundant replaceable modules.
 - 5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 6. LED indicator lights for power and protection status.
 - 7. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 8. One set of dry contacts rated at 2 A and 24-V dc, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 - 9. Surge-event operations counter: Six-digit transient counter set to total all transient surges that deviate from the fundamental sine wave by more than 125V.
 - 10. Normal Audible Noise less than 0dB.
 - 11. EMI/RFI Noise attenuation: Exceeding 30dB at 100kHz, using 50 ohm insertion loss test.
 - 12. Magnetic Fields: No appreciable magnetic fields shall be generated. The device shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

13. Leakage Current less than 1mA.

2.3 SERVICE ENTRANCE SUPPRESSORS

- A. Service Entrance Suppressors to meet "Common Requirements for Suppressors" listed above, unless otherwise indicated.
- B. Maximum Category C combination wave clamping voltage shall not exceed the following:
 - 1. 1000V, line to neutral and line to ground on 120/208 V systems.
 - 2. 1500V, line to neutral and line to ground on 277/480 V systems
- C. Withstand Capabilities: 10,000 Category C surges with less than 10 percent change in clamping voltage.
- D. Peak Single-Impulse Surge Current Rating:
 - 1. 240 kA per mode/480 kA per phase.
- E. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
 - 1. Line to Neutral: 80,000 A.
 - 2. Line to Ground: 80,000 A.
 - 3. Neutral to Ground: 50,000 A.
- F. Nominal Discharge Current I(n): 20kA.
- G. Connection Means: Permanently wired.
- H. Protection modes and UL 1449 VPR with integral disconnect for grounded wye circuits with voltages of 480Y/277 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. For Non-Fused Devices:
 - a. Line to Neutral: 1200 V for 480Y/277
 - b. Line to Ground: 1200 V for 480Y/277
 - c. Neutral to Ground: 1200 V for 480Y/277
 - 2. For Fused Devices:
 - a. Line to Neutral: 1500 V for 480Y/277
 - b. Line to Ground: 1500 V for 480Y/277
 - c. Neutral to Ground: 1500 V for 480Y/277

2.4 DISTRIBUTION PANELBOARD SUPPRESSORS

- A. Distribution Panelboard Suppressors to meet "Common Requirements for Suppressors" listed above, unless otherwise indicated.
- B. Peak Single-Impulse Surge Current Rating:
 - 1. 160 per mode/320 kA per phase.
- C. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
 - 1. Line to Neutral: 60,000 A.
 - 2. Line to Ground: 60,000 A.
 - 3. Neutral to Ground: 50,000 A.
- D. Nominal Discharge Current I(n): 20kA.
- E. Connection Means: Permanently wired.

- F. Protection modes and UL 1449 VPR with integral disconnect for grounded wye circuits with voltages of 480Y/277 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. For Non-Fused Devices:
 - a. Line to Neutral: 1200 V for 480Y/277
 - b. Line to Ground: 1200 V for 480Y/277
 - c. Neutral to Ground: 1200 V for 480Y/277
 - 2. For Fused Devices:
 - a. Line to Neutral: 1500 V for 480Y/277
 - b. Line to Ground: 1500 V for 480Y/277
 - c. Neutral to Ground: 1500 V for 480Y/277

2.5 LIGHTING AND APPLIANCE PANELBOARD SUPPRESSORS

- A. Lighting and Appliance Panelboard Suppressors to meet "Common Requirements for Suppressors" listed above, unless otherwise indicated.
- B. Peak Single-Impulse Surge Current Rating:
 - 1. 100 per mode/240 kA per phase.
- C. Nominal Discharge Current I(n): 20kA.
- D. Connection Means: Permanently wired.
- E. Protection modes and UL 1449 VPR with integral disconnect for grounded wye circuits with voltages of 480Y/277 and 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. For Non-Fused Devices:
 - a. Line to Neutral: 1200 V for 480Y/277 and 700 V for 208Y/120.
 - b. Line to Ground: 1200 V for 480Y/277 and 700 V for 208Y/120.
 - c. Neutral to Ground: 1200 V for 480Y/277 and 700 V for 208Y/120.

2.6 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected.

2.7 INTEGRAL DISCONNECT SWITCH

- A. Each device to have a NEMA compliant safety interlocked integral disconnect switch with an externally mounted metal manual operator.
- B. Switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and maintenance without interruption to the facility's distribution system.
- C. Switch shall be rated for 600Vac.
- D. Capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.
- E. Line side of the integral disconnect shall be blocked off so that when the SPD is opened there is no direct access to the voltage present on the line side of the disconnect.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multipole, 100-A frame circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated. Comply with manufacturer's written recommendation for conductor and trip rating of circuit-breaker for connecting SPD devices to distribution system. Match circuit-breaker size to conductor size.
- C. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service entrance equipment and panelboards to their sources until surge protection devices are installed and connected.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Equipment Identification Nameplates: Label each SPD with engraved Equipment Identification Label as specified in Division 26 Section "Identification for Electrical Systems."
- C. Provide a permanent label indicating UL 1449 Voltage Protective Rating (VPR) on each SPD.

3.4 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each component, connecting supply, feeder, and control circuit.
 - a. Do not perform insulation resistance tests of the distribution wiring equipment with the surge protective device installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.
 - 2. Test continuity of each circuit.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following field tests and inspections and prepare certified test reports:
 - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS 7.19.1, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 - 4. Infrared Scanning: Perform Thermographic Survey in accordance with NETA ATS, Section 9.0.
 - a. Initial Infrared Scanning: Within 60 Days after Substantial Completion, perform an infrared scan of each unit. Open or remove doors and covers so connections are accessible to portable scanner.
 - b. Instruments, Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- C. Correct Deficiencies and Report:
 - 1. Correct unsatisfactory conditions, and retest to demonstrate compliance; replace SPD, conductors, units, and devices as required to bring system into compliance.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Prepare a report, certified by testing agency, that identifies switch, connection, conductors and devices checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.6 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
 - 4. Repair exposed surfaces to match original finish.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain surge protective devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 265100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior luminaires, lamps, and ballasts.
 - 2. Solid State luminaires, and drivers.
 - 3. Emergency lighting units.
 - 4. Exit signs.
 - 5. Luminaire supports.

1.2 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated Color Temperature.
- C. CRI: Color-rendering index.
- D. CU: Coefficient of utilization.
- E. FMG: FM Global (formally Factory Mutual).
- F. HID: High-intensity discharge.
- G. LED: Light emitting diode.
- H. LER: Luminaire efficacy rating.
- I. Luminaire: Complete Lighting unit including, housing, lamps, reflector, socket, wiring, diffuser, and ballast and ballast housing where applicable.
- J. RCR: Room cavity ratio.
- K. Solid State: Lighting products that use semiconductor light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma, or gas.
- L. TM-21 L70: The time it takes a Luminaire to reach 70% Lumen maintenance based on extrapolations from LM-80-08 data using the approved methods required in IESNA Technical Memorandum 21 (TM-21).

1.3 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.

- B. Product Data: For each type of luminaire, arranged in order of fixture designation. Include data on features, accessories, finishes and the following:
1. Physical description of luminaire including dimensions.
 2. Emergency lighting units including battery and charger.
 3. Performance data for Ballast.
 4. Energy-efficiency data.
 5. Life, output, and energy-efficiency data for lamps.
 6. Photometric data, in IESNA LM-63-2002 format, based on laboratory tests of each luminaire type, outfitted with lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data.
 - b. Photometric data shall be certified by a qualified independent testing agency or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
 - c. LM-79 luminaire photometric reports for Solid State luminaires. The test laboratory must hold National Voluntary Laboratory Accreditation Program (NVLAP) accreditation for the IES LM-79 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy's CALiPER program.
 7. Solid State Luminaire reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
 - a. High Temperature Operating Life (HTOL).
 - b. Room Temperature Operating Life (RTOL).
 - c. Low Temperature Operating Life (LTOL).
 - d. Powered Temperature Cycle (PTMCL).
 - e. Non-Operating Thermal Shock (TMSK).
 - f. Mechanical shock.
 - g. Variable vibration frequency.
 - h. Solder Heat Resistance (SHR).
- C. Shop Drawings: Show details of nonstandard or custom luminaires. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
1. Wiring Diagrams: Power and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Reflected Ceiling Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electrical."
- B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- C. Qualification Data: For agencies providing photometric data for luminaires.
- D. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and accessories to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:

1. Manufacturer's routine maintenance requirements for lighting and all installed components.
 2. Special Lamp and Ballast disposal requirements; including manufacturer's safety data sheet with EPA requirements.
 3. Lamp and Ballast Summary: Prepare a tabulation of lamps and ballast used on project; include part numbers and ordering information.
- B. Warranties: Special warranties specified in this Section. Include registration information for Lamp and Ballast Specialty Warranty Programs (i.e. Sylvania Quick60+®, Advance PLUS 90 Protection®, etc).

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Battery and Charger Data: One for each emergency lighting unit.
 4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
 5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
 6. Exit Signs: 5 for every 100 of each type and installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: All luminaires with the same type designation shall be obtained from a single manufacturer. Obtain similar luminaire types through one source from a single manufacturer, unless otherwise indicated.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. FMG Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- G. Mockups: Provide interior luminaires for room or module mockups, complete with power and control connections. Refer to Division 01 for which portions of the Work require Mockups.
1. Obtain Architect's approval of fixtures for mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prepare products for shipment.
 1. Provide suitable packaging materials, crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 2. Weatherproof packaging for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Store luminaires indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect products from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Handle product components according to manufacturer's written instructions.

1.9 COORDINATION

- A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including but not limited to HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to replace ballasts replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period for Electronic Ballasts: 36 months from date of Substantial Completion.
- C. Special Warranty for Solid State Power Supplies and Drivers: Manufacturer's standard form, made out to Owner and signed by manufacturer agreeing to replace power supplies or drivers that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide luminaires in accordance with the designations and descriptions in the "Luminaire Schedule" located on the Drawings. In Luminaire Schedule, products are listed below column or row headings that introduce lists, the following requirements apply to product selection:
 1. Available Manufacturers: Where the Luminaire Schedule indicates only one product by manufacturer and associated catalog number and does not list other manufacturers by name; the design for each luminaire is based on the product

- named by manufacturer and associated catalog number scheduled. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Where the Luminaire Schedule indicates more than one manufacturer and associated catalog number; Subject to compliance with requirements, provide one of the products named by the manufacturers specified.
 3. Basis-of-Design Product: Where the Luminaire Schedule indicates only one product by manufacturer and associated catalog number and lists other manufacturers by name only; the design for each luminaire is based on the product named by manufacturer and associated catalog number scheduled. Subject to compliance with requirements; provide either the named product or a comparable product by one of the other manufacturers specified.
 4. Specific Product: Where the Luminaire Schedule indicates only one product by manufacturer and associated catalog number and does not list other manufacturers by name and includes the phrase "NO SUBSTITUTIONS ALLOWED"; the design for each luminaire is based on the product named by manufacturer and associated catalog number scheduled. Subject to compliance with requirements, provide the product named by the manufacturers specified. Provide a list of Unit Prices for these items in accordance with requirements of Division 01 Section "Unit Prices".

2.2 LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Solid State Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
 4. Laminated Silver Metallized Film: 90 percent.
- G. Plastic Diffusers, Covers, and Globes:
 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate luminaires with one filter on each ballast indicated to require a filter.

2.3 LUMINAIRE DISCONNECTING MEANS

- A. Disconnect for Ballasted Luminaires: Provide a Factory-Installed in-line disconnecting means for ballasted luminaires. Provide disconnect at each luminaire. Locate disconnect internal or external to luminaire; for disconnects external to luminaire, disconnect shall be attached to the luminaire.
 - 1. Available Manufacturers: Subject to compliance with requirements, provide Sta-Kon® Luminaire Disconnect manufactured by Thomas and Betts or similar products meeting requirement listed herein.

2.4 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Chevrons: Fixture Schedule does not indicate chevron quantity or direction. Coordinate chevron arrows required with plans. Chevrons shall be external to the lettering on sign face.
- C. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life use less than 5 watts of electricity
 - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
 - 3. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply ballast for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage

is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 LAMPS – GENERAL

- A. General: Configurations and ratings as noted in Luminaire Schedule on Drawings.
 1. Requirements: Comply with subparagraphs below for specific lamp types.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. General Electric;
 - b. OSRAM Sylvania;
 - c. Phillips;

2.7 SOLID STATE LIGHTING SYSTEMS

- A. Solid State luminaires will comply with the requirements of the following standards:
 1. ANSI/NEMA/ANSI C78.377-2008 – American National Standard for the Chromaticity of Solid State Lighting Products.
 2. LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
 3. LM-80-08, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- B. LED Chip Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Osram.
 2. Philips – LumiLEDs.
 3. Nichia.
 4. Cree.
 5. Seoul Semi-Conductor.
 6. Xicato.
 7. Bridgelux.
- C. General: Provide Solid State systems and LED components meeting the following requirements:
 1. Provide Solid State systems from same binning process to maintain color consistency.
 2. Deliver all Solid State products at the same time and store on site to ensure that products have been produced from the same bin. Tolerances exceeding 200K will not be acceptable.
 3. The Solid State Luminaires shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.

4. Provide Electrical connections protected from reverse polarity. Provide high voltage protection in the event connections are reversed or shorted during the installation process.
 5. Provide Solid State Luminaires and power/data supplies from a single manufacturer to ensure compatibility.
 6. Provide all Solid State controls, peripheral devices, and software from a single manufacturer to ensure compatibility.
 7. Conduct minimum eight-hour burn-in test during manufacturing on Solid State Luminaires (100% of each lot).
- D. White & Static Color Solid State Systems: White LED sources must meet the following requirements:
1. Luminaires must be rated for -40°C to +50°C operation.
 2. Duv tolerance of 0.001 ± 0.006 .
 3. Color Rendering Index (CRI): greater than or equal to 80.
 4. Correlated Color Temperature (CCT) as Specified in Luminaire Schedule. Meet the following tolerance requirements for CCT specified:
 - a. Nominal 2700K CCT: 2725 ± 50 .
 - b. Nominal 3000K CCT: 3045 ± 50 .
 - c. Nominal 3500K CCT: 3465 ± 50 .
 - d. Nominal 4000K CCT: 3985 ± 50 .
 - e. Nominal 4500K CCT: 4503 ± 50 .
 - f. Nominal 5000K CCT: 5028 ± 50 .
 - g. Nominal 5700K CCT: 5665 ± 50 .
 - h. Nominal 6500K CCT: 6530 ± 50 .
- E. Dynamic Color Changing Solid State Systems: RGB LED sources must meet the following requirements:
1. Luminaires must be rated for -40°C to +50°C operation.
 2. Duv tolerance of 0.001 ± 0.006 .
 3. Color Rendering Index (CRI): greater than or equal to 80 for RGB mixed white.
 4. Controllability:
 - a. 8-bit control of red, green and blue LEDs to produce 16.7 million colors or more.
 - b. Digital driver using high-speed pulse width modulation (PWM).
 - c. Integral and differential nonlinear control.
 - d. 14-bit or greater nonlinear scaling techniques for high-resolution output.
 - e. Selectable means of external control via a data network.
 - f. Support frame rates greater than 30 frames per second.
 - g. Constant data transmission rates shall be employed, resulting in the output being independent of distance of cable between power supply and light source within the specified length.
- F. Luminaire: Configurations, requirements and ratings are noted in Luminaire Schedule on Drawings. Correlated Color Temperature (CCT) is specified in Luminaire Schedule. Comply with subparagraphs below for specific luminaire types, unless otherwise indicated on Drawings:
1. Parking Garage Luminaires:
 - a. Minimum Light Output: 2000 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 50, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 100,000 Hours.
 - e. Minimum Luminaire Efficacy: 60 lumens / watt.
 - f. Housing: IP56 rated.
 2. Linear Panels, Linear Strips and Troffers:

- a. Minimum Light Output: 3000 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 80, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 50,000 Hours.
 - e. Minimum Luminaire Efficacy: 65 lumens / watt.
3. High Bay and Low Bay Luminaires:
- a. Minimum Light Output: 10,000 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 80, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 50,000 Hours.
 - e. Minimum Luminaire Efficacy: 70 lumens / watt.
4. Round and Square Aperture Downlights Luminaires:
- a. Minimum Light Output: 500 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 80, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 35,000 Hours.
 - e. Minimum Luminaire Efficacy: 40 lumens / watt.

2.8 DRIVERS FOR SOLID STATE LIGHTING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Lutron Electronics Co., Inc.
 - 2. OSRAM Sylvania.
- B. Description: Electronic programmed rapid-start type, complying with FCC Part 15 Class A or Class B, designed for type and quantity of LEDs indicated. Driver shall be designed for full light output and include dimming capability.
- 1. Compatibility: Certified by manufacturer for use with LED type provided.
 - 2. Comply with UL 8750 Class 2.
 - 3. Thermal Protection: Comply with UL Class P, Type 1 Outdoor.
 - 4. Sound Rating: Class A.
 - 5. Total Harmonic Distortion Rating: Less than 10 percent.
 - 6. Transient Voltage Protection: ANSI/IEEE C62.41, Category A or better.
 - 7. Input Voltage Range: 108-305 Volts.
 - 8. Output Voltage: not exceeding 60V (Complies with Class 2 for US).
 - 9. Maximum inrush current: 2 amperes for 120V and 277V drivers.
 - 10. Minimum Efficiency at Full Load: 85%.
 - 11. Power Factor: 0.9 or higher.
 - 12. Starting Temperature: Minus 5 Deg F (Minus 20 Deg C) minimum to 104 Deg F (40 Deg C), unless otherwise indicated.
 - 13. Case Temperature: 75 Deg C maximum, unless otherwise indicated or used in LM70 reporting.
 - 14. Housing: minimum IP20 rating for dry location installation, higher rating as required for exterior use.
 - 15. Remote Mounting Distance: Up to 18-feet, where indicated.
 - 16. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 - 17. Rated Life: minimum of 50,000 hours of rated lifetime at maximum operating conditions.
 - 18. Dimmable with standard dimmers down to 1%. 0-10V, 3-wire, or 3. Forward Phase Control (neutral wire required) (Line Voltage Controlled) Dimming as required to be compatible with lighting control system specified.

2.9 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture, unless otherwise indicated.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture, unless otherwise indicated.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- H. Suspension Bar for Light Fixtures: Factory-fabricated metal hanger for supporting luminaires at locations between ceiling system t-grid components. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. ERICO International Corporation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA/IESNA 500 "Standard for Installing Indoor Commercial Lighting" as published by the National Electrical Contractors Association.
- B. Comply with applicable portions of NECA/IESNA 502 "Standard for Installing Industrial Lighting Systems" as published by the National Electrical Contractors Association.
- C. Refer to Architectural Reflected Ceiling Plans for locations of luminaires. Do not scale locations from Electrical Drawings.
- D. Luminaires: Set level, plumb, and square with ceilings and walls. Install so as not to interfere with the installation or removal of adjacent ceiling panels.
- E. Lamps: Install lamps in each fixture.
- F. Ballasts: Provide multiple ballasts as required to accommodate multilevel switching indicated on Drawings.
- G. Flanges: Verify the exact ceiling type and arrangement within which the luminaires will be installed with the Architectural reflected ceiling plans prior to procurement. Provide

appropriate flanges and accessories with each luminaire to accommodate the defined ceiling.

- H. Support for Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element in conjunction with independent supports.
 - 1. Support Clips: Fasten to luminaires and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 2. Install at least two independent support rods or wires from structure to a tab on luminaire at opposite corners. For fixture over 48 inches (1220 mm) in length, provide intermediate independent supports at a minimum of 48 inches (1220 mm) on center. Wire or rod shall be independent of ceiling support system and shall have breaking strength of the weight of fixture at a safety factor of 3.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install fixture as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two factory-fabricated metal Suspension Bar for Light Fixtures spanning.
- I. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swaying or other horizontal movement.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with stem hangers, unless otherwise indicated.
 - 3. Fixtures Support Points: Where support points for suspended luminaires are required in locations between ceiling grip components, install at location indicated or in center in acoustical panel, and support with a factory-fabricated Tee Bar Grid Box Hanger spanning and secured to ceiling tees with integral factory-fabricated clamp.
 - 4. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end, unless otherwise indicated.

3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 CLEANING AND RELAMPING

- A. Clean components according to manufacturer's written instructions.
- B. After completing equipment installation and before substantial completion, inspect all luminaires and components.
 - 1. Remove paint splatters and other spots, dirt, fingerprints and debris.
 - 2. Repair damaged finish to match original finish.
 - 3. Dust or Vacuum interiors of suspended indirect and pendant luminaires to remove all dust, dirt, and debris.
 - 4. Clean all lenses with cleaning agent approved by Luminaire Manufacturer.
 - 5. Verify all warning labels in fixtures do not obstruct any reflective surface. Relocate warning labels as necessary so that they are not in plain view, yet they are still accessible to qualified personnel during re-lamping.
 - 6. Perform Lamp Burn-in procedure for all lamps as recommended by the lamp and ballast manufacturer prior to Final Acceptance.

3.4 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Verify transfer from normal power to battery and retransfer to normal by both of the following methods.
 - 1. Interrupt power supply to demonstrate proper operation.
 - 2. Depress Push-To-Test button to demonstrate proper operation.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 FOLLOW-UP SERVICE

- A. Final Aiming and Adjusting: Perform adjustments to all aimable and track mounted luminaires as directed by the Architect to provide required light intensities and distributions.
 - 1. Scheduling: After Substantial Completion, but not more than three months after Final Acceptance; after delivery and placement of amenities including but not limited to furniture, artwork, plantings, and signage/graphics; during a period mutually agreeable to the Architect and Owner.
 - 2. Required Equipment: Provide scaffolding, ladders, motorized man-lifts or hoists as required to reach luminaires.
 - 3. Re-Lamp: Utilizing the extra materials furnished under Part 1 above, re-lamp fixtures with new lamps having differing beam-spreads as directed by the Architect. Return all unused or minimally-used lamps to the facilities stock at the completion of the aiming and adjustment as directed by the Owner.

END OF SECTION

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SECTION 265600

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires.
 - 2. Solid State luminaire, and drivers.
 - 3. Luminaire-mounted photoelectric relays.
 - 4. Poles and accessories.
- B. Related Sections include the following:
 - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on interior surfaces of buildings.
 - 2. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for seismic design criteria for Poles, bases and accessories.

1.2 DEFINITIONS

- A. CCT: Correlated Color Temperature.
- B. CRI: Color-rendering index.
- C. HID: High-intensity discharge.
- D. LED: Light emitting diode.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete Lighting unit including, housing, lamps, reflector, socket, wiring, diffuser, and ballast and ballast housing where applicable.
- G. Pole: Luminaire support structure, including tower used for large area illumination.
- H. Standard: Same definition as "Pole" above.
- I. Solid State: Lighting products that use semiconductor light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma, or gas.
- J. TM-21 L70: The time it takes a Luminaire to reach 70% Lumen maintenance based on extrapolations from LM-80-08 data using the approved methods required in IESNA Technical Memorandum 21 (TM-21).

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design support bases and select poles and other support components for the standard mounted luminaires proposed for inclusion in the Work. Include

comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4.
- C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1.5 ACTION SUBMITTALS

- A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Common Work Results for Electrical" for products specified under PART 2 - PRODUCTS.
- B. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data, in IESNA LM-63-2002 format, based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data.
 - b. Photometric data shall be certified by a qualified independent testing agency or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
 - c. LM-79 luminaire photometric reports for Solid State luminaires. The test laboratory must hold National Voluntary Laboratory Accreditation Program (NVLAP) accreditation for the IES LM-79 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy's CALiPER program.
 - 6. Solid State Luminaire reliability reports indicating that the manufacturer of the LED (chip, diode, or package) has performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows:
 - a. High Temperature Operating Life (HTOL)
 - b. Room Temperature Operating Life (RTOL)
 - c. Low Temperature Operating Life (LTOL)
 - d. Powered Temperature Cycle (PTMCL)
 - e. Non-Operating Thermal Shock (TMSK)
 - f. Mechanical shock
 - g. Variable vibration frequency
 - h. Solder Heat Resistance (SHR)
 - 7. Photoelectric relays.
 - 8. Performance data for Ballasts, including energy-efficiency data.
 - 9. Lamps, including life, output, and energy-efficiency data.
 - 10. Materials, dimensions, and finishes of poles.

11. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
12. Anchor bolts for poles.
13. Manufactured pole foundations.

C. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Support base design, certified by a qualified professional engineer, indicating installation details of pole foundations and soil conditions on which they are based.
3. Wiring Diagrams: Power and control wiring.
4. Photometric Calculation Drawings: overall site plan prepared using computerized point-by-point analysis software based on luminaires proposed for inclusion in the Work. Plans shall indicate the following:
 - a. Illuminance levels at grade on a maximum of a 24-inch by 24-inch grid.
 - b. Schedule of Luminaires, include the following:
 - 1) Make and Model number of Luminaires.
 - 2) Description of Luminaire; including mounting and accessories.
 - 3) Lamps, including initial and maintained lumen output.
 - 4) Assumed light loss factors used in calculations.
 - c. Calculation Summary showing the following:
 - 1) Average Illuminance.
 - 2) Minimum to Maximum Ratio.
 - 3) Average to Minimum Ratio.
 - 4) Maximum illuminance at Property Line
5. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

- D. Finish Samples for Verification: Nominal 3-inch by 3-inch metal squares, factory finished for all standard finishes available; indicate specified finish with unique tag or marker.

1.6 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- B. Qualification Data: For agencies providing photometric data for Luminaires.
- C. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation And Maintenance Data," include the following:
 1. Manufacturer's routine maintenance requirements for lighting and all installed components.
 2. Special Lamp and Ballast disposal requirements; including manufacturer's safety data sheet with EPA requirements.
 3. Lamp and Ballast Summary: Prepare a tabulation of lamps and ballast used on project; include part numbers and ordering information.
- B. Warranty: Special warranty specified in this Section.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

1.9 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: All luminaires with the same type designation shall be obtained from a single manufacturer. Obtain similar luminaire types through one source from a single manufacturer, unless otherwise indicated.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C2, "National Electrical Safety Code."
- F. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Prepare products for shipment.
 - 1. Provide suitable packaging materials, crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof packaging for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Store luminaires in clean dry area in accordance with manufacturer's requirements. Protect products from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Handle product components according to manufacturer's written instructions.
- D. Package aluminum poles for shipping according to ASTM B 660.
- E. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

- F. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.11 WARRANTY

- A. Special Warranty for Luminaire and Luminaire Accessories: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, or unauthorized repairs or alterations from special warranty coverage. Manufacturer may exclude vandalism or abuse for luminaires that are not designated as high-abuse products where vandal resistance is a product requirement.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.
- B. Special Warranty for Solid State Power Supplies and Drivers: Manufacturer's standard form, made out to Owner and signed by manufacturer agreeing to replace power supplies or drivers that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: 60 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide luminaires in accordance with the designations and descriptions in the "Luminaire Schedule" located on the Drawings. In Luminaire Schedule, products are listed below column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Where the Luminaire Schedule indicates only one product by manufacturer and associated catalog number and does not list other manufacturers by name; the design for each luminaire is based on the product named by manufacturer and associated catalog number scheduled. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Where the Luminaire Schedule indicates more than one manufacturer and associated catalog number; Subject to compliance with requirements, provide one of the products named by the manufacturers specified.
 - 3. Basis-of-Design Product: Where the Luminaire Schedule indicates only one product by manufacturer and associated catalog number and lists other manufacturers by name only; the design for each luminaire is based on the product named by manufacturer and associated catalog number scheduled. Subject to compliance with requirements; provide either the named product or a comparable product by one of the other manufacturers specified.
 - 4. Specific Product: Where the Luminaire Schedule indicates only one product by manufacturer and associated catalog number and does not list other manufacturers by name and includes the phrase "NO SUBSTITUTIONS ALLOWED"; the design for each luminaire is based on the product named by manufacturer and associated catalog number scheduled. Subject to compliance with requirements, provide the

product named by the manufacturers specified. Provide a list of Unit Prices for these items in accordance with requirements of Division 01 Section "Unit Prices".

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field, where indicated in Luminaire Schedule.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Finish as indicated in Luminaire Schedule. Manufacturer's standard paint or clear coat finish and custom Colors where indicated; applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 LAMPS – GENERAL

- A. General: Configurations and ratings as noted in Luminaire Schedule on Drawings.
 1. Requirements: Comply with subparagraphs below for specific lamp types.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. General Electric;
 - b. OSRAM Sylvania;
 - c. Phillips;

2.5 SOLID STATE LIGHTING SYSTEMS

- A. Solid State luminaires will comply with the requirements of the following standards:
 1. ANSI/NEMA/ANSI C78.377-2008 – American National Standard for the Chromaticity of Solid State Lighting Products.
 2. LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
 3. LM-80-08, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- B. LED Chip Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Osram.
 2. Philips – LumiLEDs.
 3. Nichia.
 4. Cree.
 5. Seoul Semi-Conductor.
 6. Xicato.
 7. Bridgelux.
- C. General: Provide Solid State systems and LED components meeting the following requirements:
 1. Provide Solid State systems from same binning process to maintain color consistency.
 2. Deliver all Solid State products at the same time and store on site to ensure that products have been produced from the same bin. Tolerances exceeding 200K will not be acceptable.
 3. The Solid State Luminaires shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.
 4. Provide Electrical connections protected from reverse polarity. Provide high voltage protection in the event connections are reversed or shorted during the installation process.
 5. Provide Solid State Luminaires and power/data supplies from a single manufacturer to ensure compatibility.
 6. Provide all Solid State controls, peripheral devices, and software from a single manufacturer to ensure compatibility.
 7. Conduct minimum eight-hour burn-in test during manufacturing on Solid State Luminaires (100% of each lot).
- D. White & Static Color Solid State Systems: White LED sources must meet the following requirements:

1. Luminaires must be rated for -40°C to +50°C operation.
 2. Duv tolerance of 0.001 ± 0.006 .
 3. Color Rendering Index (CRI): greater than or equal to 80.
 4. Correlated Color Temperature (CCT) as Specified in Luminaire Schedule. Meet the following tolerance requirements for CCT specified:
 - a. Nominal 2700K CCT: 2725 ± 50 .
 - b. Nominal 3000K CCT: 3045 ± 50 .
 - c. Nominal 3500K CCT: 3465 ± 50 .
 - d. Nominal 4000K CCT: 3985 ± 50 .
 - e. Nominal 4500K CCT: 4503 ± 50 .
 - f. Nominal 5000K CCT: 5028 ± 50 .
 - g. Nominal 5700K CCT: 5665 ± 50 .
 - h. Nominal 6500K CCT: 6530 ± 50 .
- E. Dynamic Color Changing Solid State Systems: RGB LED sources must meet the following requirements:
1. Luminaires must be rated for -40°C to +50°C operation.
 2. Duv tolerance of 0.001 ± 0.006 .
 3. Color Rendering Index (CRI): greater than or equal to 80 for RGB mixed white.
 4. Controllability:
 - a. 8-bit control of red, green and blue LEDs to produce 16.7 million colors or more.
 - b. Digital driver using high-speed pulse width modulation (PWM).
 - c. Integral and differential nonlinear control.
 - d. 14-bit or greater nonlinear scaling techniques for high-resolution output.
 - e. Selectable means of external control via a data network.
 - f. Support frame rates greater than 30 frames per second.
 - g. Constant data transmission rates shall be employed, resulting in the output being independent of distance of cable between power supply and light source within the specified length.
- F. Luminaire: Configurations, requirements and ratings are noted in Luminaire Schedule on Drawings. Correlated Color Temperature (CCT) is specified in Luminaire Schedule. Comply with subparagraphs below for specific luminaire types, unless otherwise indicated on Drawings:
1. Outdoor Pole and Arm Mounted Area Luminaires for Roadways:
 - a. Minimum Light Output: 1000 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 50, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 50,000 Hours.
 - e. Minimum Luminaire Efficacy: 60 lumens / watt.
 - f. Housing: IP56 rated.
 2. Outdoor Wall Mounted Area Luminaires:
 - a. Minimum Light Output: 300 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 50, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 50,000 Hours.
 - e. Minimum Luminaire Efficacy: 60 lumens / watt.
 - f. Housing: IP56 rated.
 3. Outdoor Bollards:
 - a. Minimum Light Output: 500 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 6500K.
 - c. CRI: Minimum of 50, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 50,000 Hours.
 - e. Minimum Luminaire Efficacy: 60 lumens / watt.

- f. Housing: IP56 rated.
- 4. Linear Panels, Linear Strips and Troffers:
 - a. Minimum Light Output: 3000 lumens, unless otherwise indicated.
 - b. Allowable CCT per ANSI C78.377: Less than or equal to 5700K.
 - c. CRI: Minimum of 80, unless otherwise indicated.
 - d. TM-21 L70 Lumen Maintenance: 50,000 Hours.
 - e. Minimum Luminaire Efficacy: 65 lumens / watt.

2.6 DRIVERS FOR SOLID STATE LIGHTING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Lutron Electronics Co., Inc.
 - 2. OSRAM Sylvania.
- B. Description: Electronic programmed rapid-start type, complying with FCC Part 15 Class A or Class B, designed for type and quantity of LEDs indicated. Driver shall be designed for full light output and include dimming capability.
 - 1. Compatibility: Certified by manufacturer for use with LED type provided.
 - 2. Comply with UL 8750 Class 2.
 - 3. Thermal Protection: Comply with UL Class P, Type 1 Outdoor.
 - 4. Sound Rating: Class A.
 - 5. Total Harmonic Distortion Rating: Less than 10 percent.
 - 6. Transient Voltage Protection: ANSI/IEEE C62.41, Category A or better.
 - 7. Input Voltage Range: 108-305 Volts.
 - 8. Output Voltage: not exceeding 60V (Complies with Class 2 for US).
 - 9. Maximum inrush current: 2 amperes for 120V and 277V drivers.
 - 10. Minimum Efficiency at Full Load: 85%.
 - 11. Power Factor: 0.9 or higher.
 - 12. Starting Temperature: Minus 5 Deg F (Minus 20 Deg C) minimum to 104 Deg F (40 Deg C), unless otherwise indicated.
 - 13. Case Temperature: 75 Deg C maximum, unless otherwise indicated or used in LM70 reporting.
 - 14. Housing: minimum IP20 rating for dry location installation, higher rating as required for exterior use.
 - 15. Remote Mounting Distance: Up to 18-feet, where indicated.
 - 16. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
 - 17. Rated Life: minimum of 50,000 hours of rated lifetime at maximum operating conditions.
 - 18. Dimmable with standard dimmers down to 1%. 0-10V, 3-wire, or 3. Forward Phase Control (neutral wire required) (Line Voltage Controlled) Dimming as required to be compatible with lighting control system specified.

2.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: Shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. [Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.]
- F. [Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.]

2.8 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
 - 1. Shape: ~~[Round, tapered]~~ ~~[Round, straight]~~ ~~[Square, tapered]~~ ~~[Square, straight]~~ [As indicated in Luminaire Schedule on Drawings].
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: [Single-arm], [Truss] or [Davit] as required type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
 - 1. Adapter fitting welded to pole and bracket, then bolted together with [stainless] ~~[galvanized]~~-steel bolts.
 - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 - 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

- G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- I. Galvanized Finish: After fabrication, hot-dip galvanized complying with ASTM A 123/A 123M.
- J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: ~~[As indicated in Luminaire Schedule]~~ [As selected by Architect from manufacturer's full range].

2.9 ALUMINUM POLES

- A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.
- B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
 - 1. Shape: ~~[Round, tapered]~~ ~~[Round, straight]~~ ~~[Square, tapered]~~ ~~[Square, straight]~~ [As indicated in Luminaire Schedule on Drawings].
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
 - 1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
 - 2. Finish: Same as [pole] or [luminaire], unless otherwise indicated as directed by the architect.
- F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- G. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: ~~[As indicated in Luminaire Schedule]~~ [As selected by Architect from manufacturer's full range].

2.10 DECORATIVE POLES

- A. Pole Material:
 1. Cast ductile iron.
 2. Cast gray iron, according to ASTM A 48/A 48M, Class 30.
 3. Cast aluminum.
 4. Cast concrete.
 5. Spun concrete.
 6. Steel tube, covered with closed-cell polyurethane foam, with a polyethylene exterior.
- B. Mounting Provisions:
 1. Bolted to concrete foundation.
 2. Embedded.
- C. Fixture Brackets:
 1. Cast ductile iron.
 2. Cast gray iron.
 3. Cast aluminum.
- D. Pole Finish: [As selected by Architect from manufacturer's full range]

2.11 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- B. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept ballast(s) and indicated accessories.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Comply with NECA/IESNA 501 "Standard for Installing Exterior Lighting Systems" as published by the National Electrical Contractors Association.
- B. Fasten luminaire to indicated structural supports.
 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.

- D. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Harmonic Dampener: Provide harmonic dampeners on conductors within pole.
- C. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
 - 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 - 3. Trees: 15 feet.
- D. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
 - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
 - 2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
 - 3. Install base covers, unless otherwise indicated.
 - 4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
- F. Poles and Pole Foundations Set in Concrete Paved Areas: Install saw-cut or formed control joint in concrete slab within 12-inches of pole or pole foundation. Coordinate with Division 32 Section "Concrete Paving."
- G. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
- H. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete

materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 26 Section "Underground Ducts and Raceways for Electrical Systems." In concrete foundations, wrap conduit with 20 mil polyvinyl chloride (PVC) tape with a high-tack adhesive and pipe primer to provide a corrosion- and impact-resistant seal. Apply with a 50 percent overlap.

3.6 CONNECTIONS

- A. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Secure all wiring routed inside poles using cable support grips. Remove slack in conductors to prevent lateral movement.

3.7 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.8 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with requirements of authorities having jurisdiction and the following IESNA testing guide(s):
 - a. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - b. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - c. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards and design requirements.

3.9 CLEANING AND RELAMPING

- A. Clean components according to manufacturer's written instructions.
- B. After completing equipment installation and before substantial completion, inspect all luminaires and components.
 - 1. Remove paint splatters and other spots, dirt, fingerprints and debris.
 - 2. Repair damaged finish to match original finish.
 - 3. Dust or Vacuum interiors of luminaires to remove all dust, dirt, and debris.
 - 4. Clean all lenses with cleaning agent approved by Luminaire Manufacturer.
 - 5. Verify all warning labels in fixtures do not obstruct any reflective surface. Relocate warning labels as necessary so that they are not in plain view, yet they are still accessible to qualified personnel during re-lamping.
 - 6. Perform Lamp Burn-in procedure for all lamps as recommended by the lamp and ballast manufacturer prior to Final Acceptance.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

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SECTION 270000

COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes general design requirements, administration topics, and installation for communications systems.

1.2 SYSTEM DESCRIPTION

- A. The objective of this project is to provide a complete communications cabling infrastructure system installation including, but not limited to: fiber backbone, riser system, horizontal data and voice cabling with attendant terminations, mounting equipment, cable pathway and management systems, testing and other items/materials, as specified in drawings, these specifications, and contract documents.
- B. Related Sections
 - 1. Section 260000 Electrical (including related sub-sections)
 - 2. Section 270526 Grounding and Bonding for Communications Systems
 - 3. Section 270528 Pathways for Communications
 - 4. Section 270810 Fiber Optics Testing and Measurements
 - 5. Section 271100 Communications Equipment Room Fittings
 - 6. Section 271300 Communications Backbone Cabling
 - 7. Section 271500 Communications Horizontal Cabling
 - 8. Section 274100 Audio-Visual Systems (including related sub-sections)
 - 9. Section 280000 Electronic Security (including related sub-sections)

1.3 SCOPE OF WORK

- A. This section establishes an infrastructure to be used as signal pathways for communications systems, but is not limited to the following:
 - 1. Comply with all Project Contract documents and the following requirements for a complete project installation.
 - 2. Provide a structured cabling system as described hereafter that includes, but is not limited to, supplying, installing and testing of: backbone cabling, riser cabling; data and voice horizontal cabling, cable connectors, communications outlets and terminations, and equipment racks/cabinets for networking hardware and patch panels.
 - 3. Furnish all labor, materials, tools, equipment and services for the installation described herein.
 - 4. Follow industry standard installation procedures for communications cable to assure that the mechanical and electrical transmission characteristics of this cable plant and equipment are maintained.
- B. Work of this section covers complete installation of permanent links for a data and voice communications networks utilizing copper and fiber transmission media that includes, but is not limited to the following:

1. Provide, install, terminate, test, and document all fiber and copper backbone cables, riser cables, and horizontal cables.
2. Provide and install all termination devices such as, but not limited to, modular patch panels, termination blocks, information outlets (jacks and plates), phone jacks, fiber distribution panels, bulkheads, connectors, and fiber fan out kits. Document all termination devices with proper labeling.
3. Provide in quantities specified, interconnect components such as, but not limited to, fiber patch cables, copper patch cords, and station cables.
4. Provide and install specified Telecommunication Room equipment such as, but not limited to, racks, cabinets, horizontal and vertical cable support devices, cable trays and cable runway, and required mounting brackets/hardware.
5. Provide and install UL-approved firestopping systems in all communication pass-through locations of rated ceiling, wall or floor penetrations involving, conduits, cable, and cable trays in coordination with General Contractor.
6. Provide and install grounding and bonding connection to the bus (TGMB/TGB) provided by Division 26.
7. Provide and install all appropriate consumable items required to complete the installation.
8. Coordination with other trades.
9. Provide complete documentation and demonstration of work.
10. Provide indexed and organized complete Test Results of all copper and fiber cable and their components.
11. Provide Submittals as outlined below.
12. Provide a Manufacturer's Extended Product Warranty and System Assurance Warranty for this wiring system.
13. Conduct a final document handover meeting with client, consultant, and PM to review, discuss and educate the Owner on the final product, test results, and As-Built Drawings.

C. Changes to the Scope of Work

1. Owner changes to the scope of work shall be in writing.
2. Change orders shall be submitted to the Owner/Project Manager complete with price breakdown and description for approval before any work is done.
3. The Contractor shall respond to these changes with a complete material list, including pricing, labor, and taxes in writing to be presented to the Owner for approval.
4. The Contractor shall not proceed with additional scope of work without signed approval by the Owner. Owner will not pay for additional work performed by the Contractor without written/signed approval of these changes.
5. Contractor will attach a copy of the signed change order with billing information.

1.4 PRODUCTS AND WORK BY OTHERS (NIC)

- A. The Owner may separately procure and/or provide certain equipment and component that will be installed during the course of project. Such items may not be indicated in the documents.
- B. Contractor shall cooperate with the Owner and Owner's suppliers when considering:
1. The provision and installation of phone systems, related system equipment/software, and employee station equipment/software.
 2. The provision and installation of multi-port routers, switches, and other Layer 2 / Layer 3 networking components in communications rooms.
 3. The provision and installation of Uninterruptable Power Source (UPS) devices in communications rooms.
 4. Communications grounding busbars and grounding wires connecting to the main building electrode system.
 5. Dedicated power panels, ground busbars, circuits, and utility outlets.

6. The installation and finishing of plywood backboards.
7. Building mechanical ductwork, cooling/heating system (HVAC), and environmental control sensors.
8. Communication pathway devices such as, but not limited to, cable tray and flex-tray in corridors, office spaces and open areas, outlet boxes and stub-ups, conduits, conduit sleeves, and penetrations in walls and floors.

1.5 SUBSTITUTION PROCEDURES

- A. Substitution may be considered when a product becomes unavailable through no fault of the Contractor. An alternate product must be equal to or exceed specified requirements. The material substituted shall not void, alter or change manufacturers' structured cabling system warranty.
- B. Document substitution requests with complete data substantiating compliance of proposed substitution with Contract Documents. Include in each request for substitution:
 1. Product identification, manufacturer's name and address
 2. Product Data:
 - a) Description, performance and test data, reference standards, finishes and colors.
 - b) Samples: Finishes.
 - c) Complete and accurate drawings indicating construction revisions required (if any) to accommodate substitutions.
 - d) Data relating to changes required in construction schedule.
 - e) Cost comparison between specified and proposed substitution.
- C. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- D. The Owner will be the final judge of acceptability, with review by DataCom Design Group and the distribution of the acceptance by the Architect.
- E. No substitute shall be ordered, installed or utilized without the Architect's prior written verification of acceptance from the Owner.

1.6 REFERENCES AND RELATED DOCUMENTS

- A. Drawings and General provisions of the contract, including Uniform General Conditions, Supplementary General Conditions, Architectural plans and specifications, requirements of Division 1, Electrical, Mechanical, Plumbing, Audio-Visual, Security and Communications specifications and plans, and the publications listed below apply to the Communications section, are incorporated into this specification by reference, and shall be considered a part of this section.
- B. Reference to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each in effect at the date of contract.
- C. The Contractor shall read all sections in their entirety and apply them as appropriate for work in this section.
- D. Conflicts

1. Drawings and specifications are to be used in conjunction with one another and to supplement one another.
2. In general, the specifications determine the nature and quality of the materials and tests, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to during the installation of the communications system components.
3. If there is an apparent conflict between the drawings and specifications, or between specification sections, the items with the greater quantity and/or quality shall be estimated and installed.
4. Clarification with the Owner and/or DataCom Design Group about these items shall be made in writing prior to procurement and installation.

E. Codes and Standards

1. American National Standards Institute/Telecommunications Industry Association (ANSI/TIA)
 - a) ANSI/TIA-568-C.0 "Generic Telecommunications Cabling for Customer Premises"
 - b) ANSI/TIA-568-C.1 "Commercial Building Telecommunications Cabling Standard"
 - c) ANSI/TIA-568-C.2 "Balanced Twisted-Pair Telecommunication Cabling and Components Standard"
 - d) ANSI/TIA-568-C.3 "Optical Fiber Cabling Components Standard"
 - e) ANSI/TIA-568-C.4 "Broadband Coaxial Cabling and Components Standard"
 - f) ANSI/TIA-569-C "Telecommunications Pathways and Spaces"
 - g) ANSI/TIA-606-B "Administration Standard for Commercial Telecommunications Infrastructure"
 - h) ANSI/TIA-607-B "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications"
 - i) ANSI/TIA-862-A "Building Automation Systems Cabling Standard"
 - j) ANSI/TIA-942-A: "Telecommunications Infrastructure Standard for Data Centers"
 - k) ANSI/TIA-1152: "Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling"
2. American National Standards Institute (ANSI)
 - a) ANSI C80.1 Electrical rigid steel conduit (ersc)
3. BICSI
 - a) BICSI Telecommunications Distribution Methods Manual (TDMM)
4. Federal Specifications (FS)
 - a) FS W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron
 - b) FS W-C-1094 Conduit and Conduit Fittings Plastic, Rigid
 - c) FS WW-C-566C Flexible Metal Conduit
 - d) FS WW-C-581D Coatings on Steel Conduit
5. Institute of Electrical and Electronic Engineers (IEEE)
 - a) IEEE 142-1991 Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - b) IEEE 1100-2005 IEEE Recommended Practice for Powering and Grounding Electronic Equipment

6. National Electrical Code (NEC)
 - a) NEC Article 250 - Grounding and Bonding
 - b) NEC Chapter 8 - Communications Systems
7. National Electrical Manufacturers Association (NEMA)
 - a) NEMA RN1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 - b) NEMA TC2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
 - c) NEMA TC3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
 - d) NEMA VE 1 - Metal Cable Tray Systems
 - e) NEMA VE 2 - Cable Tray Installation Guidelines
8. Underwriters' Laboratories (UL)
 - a) UL Cable Certification and Follow-Up Program
 - b) UL 6: Electrical Rigid Metal Conduit - Steel
 - c) UL 83: Thermoplastic-Insulated Wires and Cables
 - d) UL 467: Grounding and Bonding Equipment
 - e) UL 514B: Conduit, Tubing, and Cable Fittings
 - f) UL 651: Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
 - g) UL 651A: Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit
 - h) UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
9. Local, county, state and federal regulations and codes in effect as of date of installation.
10. Equipment of foreign manufacture must meet U.S. codes and standards.
 - a) It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1.7 QUALITY ASSURANCE

- A. Communications Contractor shall have a complete working knowledge of low voltage communications cabling applications such as, but not limited to data, voice and video network systems.
- B. Communications Contractor shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.
- C. Communications Contractor and individual installation crew members shall be experienced and qualified to perform the work specified herein at time of bid submission. All onsite supervision personnel that will be assigned to this project shall be listed in the Pre-Installation Submittal.
 1. 80% shall have a minimum of three (3) years of experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
 2. All installation team members must demonstrate knowledge and compliance with all applicable methods, standards, and codes.
 3. All members of the installation team shall be certified by the Structured Cabling System Assurance Warranty provider as having completed the necessary training to complete their

part of the installation and capable of an installation that falls under manufacturer's guidelines necessary to obtain the Manufacturer's System Assurance Warranty.

4. Any personnel substitutions shall be noted in writing to the Owner.

D. A BICSI RCDD shall supervise and approve all on-site work as a recognized member of the Contractor's installation team.

E. Refer also to General Conditions.

1.8 CONTRACTOR REQUIREMENTS

A. In order to accomplish the conditions of this agreement, the Contractor shall perform the specific duties listed herein.

B. Contractor shall provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete communications cabling infrastructure system. Pay all required sales, gross receipts, and other taxes.

C. Insurance

1. The Contractor shall procure, submit for review, and maintain for the duration of this agreement, insurance against claims for injuries to persons or damages to property which may arise from, or in connection with, the performance of work hereunder by the Contractor, his agents, representatives, employees or subcontractor. The Contractor shall pay the cost of such insurance.

2. The Owner, its directors, officers, representatives, agents and employees, respectively, shall have no responsibility to the Contractor with respect to any insurance in accordance with the provisions set forth herein.

D. Regulatory Requirements

1. Communications Contractor shall supply all city, county, and state telecommunication cabling permits required by Authority Having Jurisdiction (AHJ).

2. Communications Contractor shall be licensed and/or bonded as required for telecommunications/low voltage cabling systems.

E. Privacy and Confidentiality

1. The Contractor will respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to extent necessary, consistent with the legal responsibilities of the Owner policies.

2. Contractors shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this project.

F. Use of Subcontractors

1. Successful bidder shall inform the Owner's contact and General Contractor in writing about the intention to use Subcontractors and the scope of work for which they are being hired.

2. The Owner or Owner's designated contact must approve the use of Subcontractors in writing prior to the Subcontractor's hiring and start of any work.

G. The Contractor's designated Project Manager will be recognized as the single point of contact. The Project manager shall oversee all work performed to ensure compliance with specifications as outlined in bid documents (which includes all specifications, references, and drawings) to

ensure a quality installation and attend project meetings with the telecommunication consultant, the Owner and others.

H. Coordination

1. Coordinate installation work with other trades (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc.) to resolve procedures and installation placement for cable trays and cable bundle pathways.
2. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.
3. Exchange information and agree on details of equipment arrangements and installation interfaces.
4. Coordinate with electrical contractors and plan for the pathway routes used communications cabling to minimize cable lengths. Report any potential over distance cable runs for approval before pulling the cables.
5. Record agreements with other trades and distribute record to other participants, Owner and telecommunication consultant.

1.9 PRE-INSTALLATION MEETINGS

A. Communications Contractor shall attend and/or arrange a scheduled pre-installation conference prior to beginning any work of this section. This venue is to ask and clarify questions in writing with consultant and/or project manager/Owner representative.

B. Agenda

1. Safety
2. Work to be performed
3. Scheduling
4. Coordination
5. Other topics as necessary

C. Attendance

1. Communications project manager/supervisor shall attend meetings arranged by General Contractor, Owner's representatives, and other parties affected by work of this document.
2. All individuals who will serve in an on-site supervisory capacity, including project managers, site supervisors, and lead installers, shall be required to attend the pre-installation conference. Individuals who do not attend the conference will not be permitted to supervise the installation and testing of communications cables on the project.

1.10 CONTRACT ADMINISTRATION

A. DataCom Design Group may perform site visits and provide job field reports upon inspection of Contractor's installation, materials, supporting hardware, coordination with other trades and progress to schedule to the client.

B. Job Field Report outline:

1. General: The general installation progress in relation to scheduled work made by the Contractor up to that date.
2. Deficiencies and/or Items of Note: Documents observations of the cable installation that may require corrective action by the Contractor.

1.11 POST INSTALLATION MEETINGS

- A. At the time of substantial completion the contractor shall call and arrange for a post installation meeting to present and review all submittal documents to include but not be limited to As-Built Drawings, Test reports, Warranty paperwork, etc.
- B. Attendees shall include
 - 1. Communications Contractor
 - 2. Project Manager/Owner Representative
 - 3. DataCom Design Group
 - 4. General Contractor
 - 5. Other trades that the GC deems appropriate.
- C. At this meeting the Communications Contractor shall present and explain all documentation.
- D. Any discrepancies or deviations noted by and agreed to by participants shall be remedied by the Communications Contractor and resubmitted within one (1) week of the meeting.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.
- B. Communications Contractor requirements:
 - 1. Be responsible for prompt material deliveries to meet contracted completion date.
 - 2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
 - 3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
 - 4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
 - 5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
 - 6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
 - 7. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
 - 8. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.
- C. Owner/General Contractor shall provide the security requirements for Contractor to follow.

1.13 PROJECT/SITE CONDITIONS

- A. For all environmental recommendations, refer to master Architectural section.
- B. For all security recommendations, refer to related consultant sections.
- C. Contractor shall provide daily a clean work environment that is free from trash/rubbish accumulated during and after cabling installation.

- D. Contractor shall keep all liquids (drinks, sodas, etc.) away from finished spaces. If any liquid or other detriment (cuts, soils, stains, etc.) damages any finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.
- E. Damage by Communications Contractor to the work of others will be remedied at the Contractor's expense in a timely manner.

1.14 WARRANTY

- A. The Contractor shall be a certified Manufacturer's Value Added Reseller (VAR) and/or Authorized Installer and provide an end-to-end product warranty, adhere to the industry standard engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project.
- B. Contractor shall coordinate with manufacturer for warranty paperwork and procedures prior to the start of the project.
- C. Contractor shall provide a minimum one (1) year warranty on installation and workmanship PLUS an Extended Product Warranty and System Assurance Warranty for this wiring system and shall commit to make available local support for the product and system during the Warranty period.
 - 1. The Extended Product Warranty shall apply to all passive structured cabling system components and shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products for a minimum of one (1) year.
 - 2. The System Assurance Warranty provides a complete system and product warranty that will be extended to the end-user, ensuring the structured cabling system will be free of defects in materials and workmanship, will meet or exceed applicable performance requirements defined in the contract documents, and support all current and future network applications for a minimum of twenty (20) years.
- D. System Certification: Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturer, registering the installation.

1.15 PAYMENT

- A. Refer to the General Contractor contract documents and/or master specifications issued by Architect for project and cost payment details.

1.16 SUBMITTALS

- A. Refer to Requirements of Division 1
- B. Refer to Sections 271300 and 271500.
- C. The Communications Contractor shall not perform any portion of the work requiring submittal and review of shop drawings, product data, or samples until Owner has approved the respective submittal in writing. Such work shall be in accordance with approved submittals.
- D. Pre-Installation Submittal Requirements
 - 1. Communications Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.

2. City, county, and/or state telecommunication cabling permits as required by Authority Having Jurisdiction (AHJ).
3. Executed non-disclosure agreement.
4. Appoint a Project Manager and provide the name and contact information.
5. Shop Drawings
 - a) Communications Contractor shall submit, for approval, floor plans that identify all device locations, cable routes and quantities, cable types, riser locations, and references to installation details and diagrams.
 - 1) Communication Contractor shall notify Owner of cable routes exceeding standardized lengths.
 - b) Communications Contractor shall submit, for approval, diagrams that show room layouts, rack layouts (including elevations), riser layouts, etc.
 - c) The Contractor shall make any corrections as required by the consultant team and submit revised shop drawings to the team for approval.
 - d) Approval by the Consultant of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from the drawings or specifications, nor shall it relieve the Contractor from responsibility for errors of any sort in shop drawings or schedules. Requests to deviate shall be submitted in writing to the Architect.
 - e) Release of CAD Files
 - 1) Contractor may request to utilize the DataCom Design Group AutoCAD floor plan files for assistance in producing shop drawings.
 - 2) Request shall be made by signing the DataCom Design Group "Agreement for Release of CAD Files" letter.
6. Product Data Cut-sheets
 - a) Communications Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection.
 - b) Communications Contractor shall identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
7. Warranty
 - a) The Communications Contractor shall submit appropriate documentation from the certifying manufacturer showing the project is registered and qualified for the System Assurance Warranty.
 - b) All subsequent work shall be in accordance with approved submittals. The Communications Contractor shall not perform any portion of the work requiring approval of the System Assurance Warranty manufacturer's warranty registration qualification procedures that would disqualify any part or all of the wiring system from that warranty qualification.
8. Qualifications
 - a) Communications Contractor shall submit a list of the Contractor's previous projects that demonstrate qualification for this project. This list shall include, but not be limited to:

- 1) At least ten (10) other projects in the last five (5) years
 - 2) Name and location of project
 - 3) Project contacts, email addresses, and phone numbers
 - 4) Total square footage
 - 5) Total number of cables/drops
 - 6) Types of media
 - b) Communications Contractor shall submit an up-to-date and valid statement of qualifications for those assigned to perform the work specified herein at time of bid submission.
 - 1) Communications Contractor Employees
 - 2) Subcontractors
 - c) Manufacturer certifications for Contractor and installers.
9. Cable Testing Plan
- a) The Contractor shall provide a complete and detailed test plan for approval of the cabling system specified herein, including a complete list of test equipment for copper and fiber components and accessories prior to beginning cable testing.
 - b) The following minimal items shall be submitted for review:
 - 1) A testing plan that clearly describes procedures and methods.
 - 2) Product data for test equipment.
 - 3) Certifications and qualifications of all persons conducting the testing.
 - 4) Calibration certificates indicating that equipment calibration meets National Institute of Standards and Technology (NIST) standards and has been calibrated at least once in the previous year of the testing date.
 - 5) Examples of test reports, including all graphs, tables, and charts necessary for display of testing results.

10. Samples

- a) For workstation outlet connectors, jack assemblies, housings and faceplates for color selection and evaluation of technical specifications and requirements. Confirm with Architect, interior designer, and Owner representative for color before purchasing materials.

E. Closeout Submittal Requirements

1. As-Built Drawings

- a) Communications Design drawings are to be supplied to the Architect to prepare the master "As-Built" drawings.
- b) Submit one electronic copy and one hard copy with project deliverables within three (3) weeks subsequent to substantial completion. Provide a laminated floorplan with drop designations in the respective serving Telecom Room.
- c) As-Built drawings shall be in AutoCAD format, same version as used by Architect and consultant. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing sheets used for the contract documents.
- d) Utilize normal recognized drafting procedures that match AutoCAD standards, Architect and Consultant guidelines, and methodology.

- e) The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.
 - 1) Contractor shall clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.
 - 2) Maintain drawing numbering or page/sheet scheme consistency as per previously issued drawings/documents.
- f) Provide dimensioned plan and elevation views of networking components, showing:
 - 1) All work area outlet locations complete with outlet/cable labeling.
 - 2) Rack and/or cabinet locations complete with labeling.
 - 3) One-line diagram of equipment/device interconnections with the cable plant.
 - 4) Standard or typical details of installations unique to Owner's requirements.
 - 5) Graphic symbols and component identification on detail drawing shall conform to the latest conventions:
 - i) ANSI/TIA-568-C.0 "Generic Telecommunications Cabling for Customer Premises"
 - ii) ANSI/TIA-569-C "Telecommunications Pathways and Spaces"
 - iii) ANSI/TIA-606-B "Administration Standard for Commercial Telecommunications Infrastructure"
 - iv) ANSI/TIA-607-B "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications"
- 2. The Communications Contractor shall deliver the Installer's Extended Product Warranty and Manufacturer's signed System Assurance Warranty of installed cabling system to include all components that comprise the complete cabling system.
 - a) Delivery shall be completed within two (2) weeks of the time of final punch list review.
 - b) Product Certificates shall be signed by manufacturers of cables, connectors, and terminal equipment certifying that products furnished comply with requirements.
- 3. Cable Testing Report Requirements
 - a) Submit certified test reports of Contractor-performed tests. Contractor shall submit the required Test Reports in the format and media specified, upon completion of testing the installed system.
 - b) The tests shall clearly demonstrate that the media and its components fully comply with the requirements specified herein.
 - c) Three (3) sets of electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable designations.
 - d) Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination components. Include products furnished:
 - 1) Manufacturer's name
 - 2) Manufacturer's part numbers
 - 3) Cable designations
 - 4) Location and riser assignments
 - 5) Product Data
- 4. Supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

- F. The Contractor's BICSI Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all documents prior to submitting. The Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein upon completion of all work.

PART 2 - PRODUCTS

2.1 SUMMARY

- A. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
- B. All material and equipment, as provided, should be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products.
 - 1. All shall be typical commercial designs that comply with the requirements specified.
 - 2. All material and equipment shall be readily available through manufacturers and/or distributors.
- C. All equipment shall be standard catalogued items of the manufacturer and shall be supplied complete with any optional items required for proper installation.
- D. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.
- E. All materials shall be UL- and/or ETL-approved and labeled in accordance with NEC for all products where labeling service normally applies.
- F. Materials and equipment requiring UL 94, 149 or 1863 listing shall be so labeled. Modification of products that nullifies UL labels is not permitted.
- G. Backward Compatibility: The provided products shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower category's specified parameters.
- H. Component Compliance: The provided products shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.

2.2 ACCEPTABLE MANUFACTURERS

- A. Identification (Labeling) System
 - 1. Brady
 - 2. Dymo
 - 3. Hellerman-Tyton
 - 4. Acceptable alternate
- B. Fire-Stop Systems

1. Hilti
2. SpecSeal
3. 3M
4. Acceptable alternate

C. Other Products as Referenced in other Division 27 Specifications.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field Measurements

1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

B. Established Dimensions

1. Where field measurements cannot be made without delaying the work, coordinate with the General Contractor to establish dimensions.
2. When approved in writing, proceed with fabricating units without field measurements.
3. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

C. Pre-installation inspection

1. The Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.
2. Visibly damaged goods are not acceptable and shall be replaced by the contractor at no additional cost to the Owner.

3.2 INSTALLATION

A. General

1. Contractor shall install work in accordance with specifications, drawings, manufacturer's instructions and approved submittal data.

B. Allowable cable bend radius and pull tension:

- a) In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation.
- b) Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
- c) After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

C. Pull Strings

1. Provide pull strings in all new conduits, including all conduits with cable installed (trailer strings) as part of this contract.
2. Data and video cables can be pulled in tandem with pull strings.

3. The pull strings must move freely to prevent cable jacket/cable damage during pulls.

D. Labeling

1. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.
2. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.
3. Provide transparent plastic label holders, and 4-pair marked colored labels.
4. In accordance with ANSI/TIA-606-B "Administration Standard for Commercial Telecommunications Infrastructure":
 - a) Install colored labels according to the type of field as per color code designations.
 - b) Use "designation strip color-code guidelines for voice, data, cross-connect, riser, and backbone fields".
5. Pathway Labels and Labeling System
 - a) Labeling system shall consist of a hand-held portable printer
 - b) Conduits: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive. Label size shall be appropriate for the conduit size. Font size shall be legible from the finished floor.
 - c) Inner duct: Polyethylene general-purpose tagging material attached using tie wraps.
 - d) Junction boxes: General-purpose label designed for powdered coated surfaces with an ultra-aggressive adhesive, trade name. Font size shall be easily visible from the finished floor.
 - e) All labels shall be permanent, i.e. will not fade, peel, or deteriorate due to environment or time.
 - f) Identification
 - 1) All conduits, junction boxes, gutters, and pull boxes shall have machine-generated labels easily visible from the finished floor.
 - 2) Conduits shall be labeled with the word "communications" and the conduit's origination room number and destination room number.
 - 3) The Contractor shall label conduit at each wall and floor penetration and at each conduit termination, such as outlet boxes, pull boxes, and junction boxes, or as otherwise specified in other sections.
 - 4) Junction boxes, gutters and pull boxes shall be labeled with identification name or number as determined by contractor and submitted for approval.
 - 5) The Contractor shall label conduit sleeves at each wall and floor penetration.

E. Firestop

1. Provide approved fire-resistant materials to restore originally-designed fire-ratings to all wall, floor, and ceiling penetrations used in the distribution and installation for communications cabling system.
2. Install and seal penetrations (conduit, sleeves, slots, chases) in fire-rated barriers created for communications infrastructure to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.
3. The firestopping material shall maintain/establish the fire-rated integrity of the wall/barrier that has been penetrated.
4. All through penetrations in a fire rated surface require a sleeve, regardless of penetration diameter or penetrating cable count.

5. Using a "ring and string" method of installing cabling for membrane penetrations in a wall cavity is acceptable, provided the solution was accepted by the Owner in writing. Code-compliant firestopping rules still apply.
 6. Coordinate firestopping procedures and materials with General Contractor.
 7. Sharing the pathway of other trades/utilities through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.
 8. Provide and install removable, intumescent mechanical systems in floor chases for all openings greater than 0'-4".
 9. Provide and install removable, intumescent, firestop bricks for all openings greater than 0'-4" where there are penetrations through walls.
 10. Bricks shall be listed for insertion in fire-rated openings and require restraining materials or apparatus as needed per manufacturers' specifications.
 11. Provide manufacturer recommended material for rated protection for any given barrier.
 12. Laminate and permanently affix adjacent to chases the following information:
 - a) Manufacturer of firestop system.
 - b) Date of installation/repair.
 - c) Part and model numbers of system and all components.
 - d) Name and phone numbers of local distributor and manufacturer's corporate headquarters.
 13. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.
 14. Materials shall be installed per manufacturer instructions, be UL-listed for intended use, and meet NEC and locals codes for fire stopping measures.
 15. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.
 16. Develop training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.
- F. Within the normal environment, the installed systems shall not generate nor be susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, or obstructs any equipment.
- G. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in structure cable system capacity.
- H. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.
- I. System Tests
1. Upon completion of the installation of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.
 - a) Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
 - b) Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.
 - c) Approved instruments, apparatus, services, and qualified personnel shall be utilized.

- d) The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.
- e) This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.

2. Non-Compliant Cabling

- a) Testing that shows some or all pairs of a cable do not comply with specifications, without written approval by the Owner, shall be replaced at Contractor's expense (including respective connectors).
- b) With the Owner's written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.
 - 1) Testing is still required for non-compliant cabling.
 - 2) The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to-ground.
 - 3) The test results must be within acceptable tolerances and shall be submitted with the Owner's acceptance document.

3. Failed Tests

- a) If tests fail, Contractor shall correct as required to produce a legitimate passing test.
- b) Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.
- c) If the Contractor is found to have manipulated or falsified any failing test result to show a "PASS" for any reason (without written notice and prior approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

4. Owner reserves the right to be present during any or all testing.

3.3 CLEANING

- A. The Contractor will clean all surfaces prior to final acceptance by Owner.

3.4 COMPLETION INSPECTION AND PUNCH LIST

- A. When the Contractor determines that the Scope of Work has been completed in accordance with the plans and specifications, Contractor shall schedule a Completion Inspection with the Owner.
- B. A Punch List will be generated during the Completion Inspection containing deficiencies in need of corrective action.
- C. Complete all punch list deficiencies within 10 working days. The work is not complete until all punch list deficiencies have been addressed.

3.5 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with contract documents, the Owner shall notify Contractor in writing of formal acceptance of the system.
- B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).
- C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as described herein.

END OF SECTION

SECTION 270526

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes grounding and bonding products, design requirements and installation for communications systems.
- B. Related Sections
 - 1. Section 260000 Electrical (including related sub-sections)
 - 2. Section 270000 Communications
 - 3. Section 270528 Pathways for Communications Systems
 - 4. Section 270810 Optical Fiber Testing and Measurements
 - 5. Section 271100 Communications Equipment Room Fittings
 - 6. Section 271300 Communications Backbone Cabling
 - 7. Section 271500 Communications Horizontal Cabling
 - 8. Section 274100 Audio-Visual Systems
 - 9. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

- A. The publications referenced in Section 27 00 00 form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts
 - 1. Refer to Section 270000.
- D. Codes and Standards
 - 1. Refer to Section 270000.

1.3 SYSTEM REQUIREMENTS

- A. General
 - 1. All conductor wire, busbars and conduit shall be UL listed.
 - 2. The communications ground system shall be independent from all power grounding except for the connection to the building's electrical service main grounding electrode system.
 - 3. Power grounding and/or bonding shall not be allowed to interfere or provide any back feed or be a conductor to the separate communications ground system source or to any communications bonded materials or equipment.

- B. Telecommunications Main Grounding Busbar (TMGB) and Bonding Conductor for Telecommunications (BCT)
 - 1. The main ground source feed for the Telecommunications Main Grounding Busbar (TMGB) in the MC (MDF) shall be an independent feed from the building's electrical service main grounding electrode system, known as the Bonding Conductor for Telecommunications (BCT).
 - 2. The BCT shall be a stranded copper ground wire from the building ground system to the TMGB in the MC (MDF) sized at a minimum #4/0 unless otherwise sized by the Electrical Engineer of Record.
 - 3. The BCT connections shall be low emission exothermic welds at the connecting ends.
- C. Telecommunication Bonding Backbone (TBB) and Telecommunications Grounding Busbar (TGB)
 - 1. The Telecommunication Bonding Backbone (TBB) originates at the TMGB and shall be extended from the TMGB within the MC (MDF) throughout the building along the same route as the telecommunications backbone pathways, to the Telecommunications Grounding Busbar(s) (TGBs) in each TR (IDF).
 - 2. The minimum TBB conductor size between busbars shall be a stranded copper ground wire one (1) AWG size smaller than the Bonding Conductor for Telecommunications (BCT).
- D. TEBC and RBC
 - 1. All cabinets and racks shall be connected by the Telecommunications Equipment Bonding Conductor (TEBC). The TEBC is a stranded copper #4 conductor from the TMGB/TGB extending along each row of racks within the room. Bond each rack with a Rack Bonding Conductor (RBC). The RBC is a stranded copper #6 conductor connected to the vertical rack bonding terminal. All connections shall be irreversible crimp connections. Route conductor so as to minimize the quantity of sweeping bends.

1.4 SUBMITTALS

- A. Refer to Section 270000.

1.5 QUALITY ASSURANCE

- A. Refer to Section 270000.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 270000.
- B. The Contractor shall ship on manufacturer's standard reel sizes of one continuous length. Where cut lengths are specified, mark reel quantity accordingly.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers that may be incorporated in the work, include:
- B. Cable Manufacturers
 - 1. Houston Wire and Cable Company
 - 2. Okonite Company
 - 3. General Cable
 - 4. Pirelli Cable Corporation
 - 5. Triangle Wire and Cable
 - 6. Owner Approved Alternate
- C. Electrical Service Entrance Bonding Conductor and Connector Manufacturers
 - 1. Copperweld
 - 2. Thomas & Betts
 - 3. Blackburn
 - 4. Owner Approved Alternate
- D. Exothermic Connector Manufacturers
 - 1. Erico Products (Cadweld)
 - 2. Continental Industries (thermOweld)
 - 3. Harger
 - 4. Owner Approved Alternate
- E. Crimp Connector Manufacturers
 - 1. Thomas & Betts
 - 2. FCI Burndy Electrical
 - 3. O-Z/Gedney
 - 4. Owner Approved Alternate
- F. Telecommunication Grounding Busbars
 - 1. Chatsworth
 - 2. Panduit
 - 3. Leviton
 - 4. Owner Approved Alternate
- G. Bonding Straps
 - 1. Chatsworth
 - 2. Harger
 - 3. Brundy
 - 4. Owner Approved Alternate
- H. C-Type Compression Taps
 - 1. Brundy
 - 2. Harger
 - 3. Owner Approved Alternate
- I. Antioxidant Joint Compound

1. Chatsworth
2. Owner Approved Alternate

J. Labeling

1. Refer to Section 270000.

K. Firestopping

1. Refer to Section 270000.

2.2 MATERIALS

A. Communications Grounding Conductors: Copper American Wire Gauge (AWG) wire of the following sizes:

1. Bonding Conductor for Telecommunications (BCT): #4/0 (unless otherwise sized by the Electrical Engineer of Record)
2. Telecommunication Bonding Backbone (TBB): #3/0 (unless otherwise sized by the Electrical Engineer of Record)
3. Grounding Equalizer (GE): equal AWG as the TBB (unless otherwise sized by the Electrical Engineer of Record)
4. Telecommunications Equipment Bonding Conductor (TEBC): #4
5. Rack Bonding Conductor (RBC): #6

B. Grounding Connectors

1. Connectors shall be a copper alloy material and two-hole, double-crimp compression lug type at the connecting ends.

C. Telecommunications Main Ground Busbar (TMGB)

1. Use pre-drilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors.
2. Sized for the immediate requirements and allow for 25% growth.
3. The minimum dimensions shall be 0'-1/4" thick X 0'-4" wide X 2'-0" long.
4. Contain (2) tiers of pre-drilled holes for use with standard sizes of two-hole copper compression lugs.
5. ASTM-B187-C11000 Copper bar suitable for use with two-hole compression-type copper lugs.

D. Telecommunications Ground Busbar (TGB)

1. Use pre-drilled copper busbar with standard NEMA bolt hole sizing and spacing for the type of connectors.
2. Sized for the immediate requirements and allow for 25% growth.
3. The minimum dimensions shall be 0'-1/4" thick X 0'-4" wide X 0'-10" long.
4. Contain (2) tiers of pre-drilled holes for use with standard sizes of two-hole copper compression lugs.
5. ASTM-B187-C11000 Copper bar suitable for use with two-hole compression type copper lugs.

E. Equipment Cabinet and Rack Ground Busbar

1. Provide and install a vertical ground busbar in all racks and equipment cabinets to be used as an equipment grounding bus.
2. The busbar shall be equal-flange (channel) 1'-7" (19) rack width and shall include ground bar, splice plate and #12-24 mounting hardware.
3. The minimum dimensions shall be 0'-3/4" in width by 0'-3/16" in thickness.
4. The busbar shall have pre-drilled holes and shall be suitable for use with two-hole compression-type copper lugs.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 270000.

3.2 PREPARATION

- A. Refer to Section 270000.
- B. Copper and copper alloy connections should be cleaned prior to connection.

3.3 INSTALLATION

- A. Refer to Section 270000.
- B. The Contractor shall install the work in accordance with the specifications, drawings, manufacturer's instructions and approved submittal data.
- C. All work shall be supervised and reviewed by the Contractor's on-site RCDD.
- D. Installation plans and Requests For Information (RFIs) shall be reviewed by the Contractor's RCDD.
- E. General
 1. Bonding and grounding procedures and components shall comply with ANSI/TIA-607-B "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications".
 2. Bonding should be accomplished such that the bonding system is integrated and compliant with NEC specifications.
 3. Bonding conductors shall be routed with minimum bends or changes in direction and should be made directly to the points being bonded.
 4. Bonding connections should be made by using compression copper lugs. However, for parts of the ground electrode system that are subject to corrosion, must carry high currents reliably, or for locations that require minimum maintenance, connections are made with low emission exothermic welding (see NEC Article 250).
 5. Make connections to dry surfaces only.
 6. Remove paint, rust, oxides, scales, grease and dirt from surfaces before making connection.

7. Burnish clean a 0'-1" X 0'-1" area, drill, tap, apply an adequate amount of antioxidant joint compound mixed for the metal surface types affected, and bolt conductor and connector to burnished and compounded area. Ensure proper conductivity.
8. Route bonding conductor(s) the shortest distance between bonding contact points.
9. The ground-wire connecting ends shall have a minimum amount of insulation removed at the ground lug.
10. Do not connect ground wire in power cable assemblies to the telecommunications ground system.
11. All grounding and bonding conductors shall be copper and may be insulated. If bare-bonding conductors are used, isolate bonding conductors and prevent contact.
12. Antioxidant material shall be installed to separate dissimilar metals and prevent corrosion.
13. If multiple systems are involved (lightning protection systems, communications, radio and TV, CATV, etc.), those systems shall be bonded together to minimize potential differences between the systems, per NEC 250.94.

F. Telecommunication Bonding Conductors

1. Each telecommunications grounding and bonding conductor shall be labeled at each end detailing the function and room number of its opposite end. Labels shall be located on conductors as close as practicable to their point of termination in a readable position. Labels shall be nonmetallic and include the following text, "TELECOMMUNICATIONS GROUND - DO NOT REMOVE. IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER".
2. Furnish and install all required bonding material, hardware, and utilize tools manufactured for this purpose.
3. The connections of the BCT, TBB, GE, TEBC, and RBC shall be made using low emission exothermic welding or hydraulically crimped with a double crimp connector. Two-hole grounding lugs are preferred for connection to the grounding bus bars.
 - a) All low emission exothermic welding shall be by Division 26.
 - b) Coordinate with the building services personnel in occupied spaces to prevent the smoke from the exothermic weld process from potentially setting off smoke/fire alarms.
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in a ferrous metallic conduit that exceeds 1m (3ft) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6AWG conductor, minimum.
5. The bonding conductors should be installed without splices.
 - a) Where splices are necessary, the number of splices should be minimized, be accessible, and be located within the telecommunications spaces.
 - b) Joined segments of a bonding conductor shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.

G. Equipment Cabinets and Racks

1. The busbar shall be installed at the base and back of each cabinet/rack for floor fed cabinets/racks.
2. The busbar shall be installed at the top and back of each cabinet/rack for top fed cabinets/racks.
3. Each cabinet and rack shall be provided with a minimum # 6 AWG ground wire.

4. Do not loop from cabinet/rack to cabinet/rack.
5. Each cabinet or rack bay against the wall shall be bottom/side ground fed from the wall.
 - a) Wall ground feeds/raceways to racks shall not be exposed on the walls.
 - b) Exception: Some cabinet or rack bays will require the ground to be fed from the ceiling raceway.
6. All ground raceways within each cabinet/rack or cabinet base and adjacent-ganged cabinet base shall be an insulated metallic flex type raceway and shall not interfere with equipment mounting frames or equipment mounting brackets.

H. Cable Runway, Cable Raceway and Support System Grounding

1. The Contractor shall provide communications cable tray and cable runway systems with a communications dedicated ground from the TGB.
2. All cable tray needs to be electrically continuous per NEC 250.96.
 - a) Metal raceways, wire-mesh cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as an alternate grounding path, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current plausibly to be imposed on them.
 - b) Any nonconductive paint, enamel, or similar coating shall be removed at the threads, contact points, and contact surfaces.
 - c) Grounding or bonding conductors shall be connected by fittings designed for that purpose to ensure adequate bonding.
3. The Contractor shall provide and install a #6 AWG ground wire to bond one end of each cable tray/runway system to the TGB.
4. For electrically non-continuous conduits that contain only grounding conductor, the Contractor shall bond the conduit and conductor together at both ends to ground to the nearest TGB with grounding bushings or ground clamps.

I. Shielded Backbone Cabling

1. The Contractor shall terminate and bond the shield to the nearest TGB or TMGB at both ends, following manufacturer's guidelines.

3.4 FIELD QUALITY CONTROL

A. Testing

1. Upon completion of the electrical system, including all grounding, the Electrical Contractor shall test the system for stray currents, ground shorts, etc.
2. Approved instruments, apparatus, services, and qualified personnel shall be utilized.
3. If stray currents, shorts, etc., are detected, eliminate or correct as required.

END OF SECTION

SECTION 270528

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Hangers and Supports, including open-top supports (cable hooks) for communications systems.
2. Conduits and Pull Boxes for communications systems.
3. Cable Tray and Cable Runway with associated accessories and fittings for communications systems.

B. Related Sections

1. Section 260000 Electrical (including related sub-sections)
2. Section 270000 Communications Systems
3. Section 270526 Grounding and Bonding for Communications Systems
4. Section 270810 Optical Fiber Testing and Measurements
5. Section 271100 Communications Equipment Room Fittings
6. Section 271300 Communications Backbone Cabling
7. Section 271500 Communications Horizontal Cabling
8. Section 274100 Audio-Visual Systems
9. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

- A. The publications referenced in Section 270000 form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts
 1. Refer to Section 270000.
- D. Codes and Standards
 1. Refer to Section 270000.

1.3 SUBMITTALS

- A. Refer to Section 270000.

1.4 QUALITY ASSURANCE

- A. Refer to Section 270000.

1.5 DELIVERY, STORAGE, and HANDLING

- A. Refer to Section 270000.

- B. Conduit Storage

1. Package conduits in bundles maximum 10'-0" long, with conduit and coupling thread protectors for indoor/outdoor storage.
2. Package fittings in manufacturer's standard quantities and packaging suitable for indoor storage.
3. Protect coating on plastic-coated rigid conduit, fittings, and bodies from damage during shipment and storage.
4. Store conduit above ground on horizontal racks to prevent corrosion and entrance of debris.
5. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Protect plastic conduit and inner duct from sunlight. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers that may be incorporated in the work, include:

- B. Cable Hooks

1. Cooper B-Line, Inc.
2. Erico
3. Caddy
4. Owner approved alternate

- C. Basket Tray

1. Cooper B-Line, Inc.
2. Chatsworth (CPI)
3. Hoffman
4. WBT Wire Mesh
5. Owner approved alternate

- D. Polyethylene Cable Support System

1. Erico
2. Owner approved alternate

- E. Innerduct

1. Carlon Riser Guard Flexible Raceway (corrugated innerduct)
2. MaxCell (fabric innerduct)
3. Owner approved alternate

F. In Floor Infrastructure Termination Box

1. FSR FL-200

G. Lead Lined Backboxes in X Ray Rooms (See Division 26)

1. Owner approved

H. Measured pull tape (pull tape printed with sequential footage markings)

1. Fibertek
2. Condux International
3. Owner approved alternate

I. Labeling

1. Refer to Section 270000.

J. Firestopping

1. Refer to Section 270000.

2.2 CABLE HOOKS

A. Cable hooks shall be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

B. Features

1. Cable hooks shall have a flat bottom and provide a minimum of 0'-1.625" cable-bearing surface.
2. Cable hooks shall have 90° radius edges to prevent damage while installing cables.
3. Cable hooks shall be designed so that the mounting hardware is recessed to prevent cable damage.
4. Cable hooks for non-corrosive areas shall be pre-galvanized steel. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish.
5. Cable hooks for corrosive areas shall be stainless steel.
6. Cable hooks shall have a stainless steel cable latch retainer to provide containment of cables within the hook.
7. The retainer shall be removable and reusable.

C. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.

D. Load cable hooks in accordance with manufacturer requirements and recommendations.

E. Provide capacity for 20% growth, add additional hooks as needed.

2.3 PULL BOXES, JUNCTION BOXES, AND GUTTERS

- A. All junction boxes, gutters and pull boxes shall be UL listed and comply with NEC requirements.
- B. All junction boxes, gutters and pull boxes shall meet the following minimum material requirements:
 - 1. 16-gauge steel or heavier
 - 2. Seams shall be continuously welded and grounded smooth
 - 3. External screws and clamps
 - 4. External mounting feet (where applicable)
 - 5. Oil-resistant gasket and adhesive
 - 6. ANSI 61 gray polyester powder coating inside and out over phosphatized surface
- C. All junction boxes, gutters and pull boxes shall be provided with bushings for conduits and/or cabling.
- D. All junction boxes, gutters and pull boxes shall be securely installed.

2.4 CONDUITS

- A. All conduits shall be UL listed and comply with NEC requirements.
- B. Conduit Fittings
 - 1. All fittings shall be compression or threaded.
 - 2. Fittings shall provide a secure connection for pulling communications cables.
 - 3. Setscrew fittings are not permitted.
 - 4. Conduit "condulets" are not permitted.
- C. Non-metallic conduits are not permitted in above ground installations. Conversion fittings are required for non-metallic (below ground) to metallic (above ground) transitions.
- D. Innerduct:
 - 1. All fiber shall be installed in innerduct unless fiber cabling is armored.
 - 2. Shall be constructed of non-metallic material.
- E. Only manufacturer's fittings, transition adapters, terminators and fixed bends shall be used.
- F. Measured Pull Tape
 - 1. Pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn with footage markers printed on the tape.
 - 2. Minimum average tensile strength shall be 1130 lbs. for 0'-1.5" and smaller conduits and innerduct.
 - 3. Minimum average tensile strength shall be 1800 lbs. for conduits larger than 0'-1.5".
- G. Fill and Bend Radius
 - 1. Conduit fill shall comply with NEC requirements.
 - 2. The minimum bend radius is 6 X the conduit inside diameter (ID) for 0'-2" conduit or less.
 - 3. The minimum bend radius is 10 X the conduit ID for a conduit greater than 0'-2".
 - 4. There shall be no more than two 90° bends (180° total) between conduit pull boxes.

5. Changes in direction shall be accomplished with sweeping bends observing minimum bend radius requirements above.
6. Do not use pull boxes for direction changes unless specifically designated otherwise in the drawings.
7. Unless otherwise noted in the drawings, conduits entering pull boxes shall be aligned with exiting conduits.

H. Routing

1. Conduits shall be routed in the most direct route possible, with the fewest number of bends possible.
2. There shall be no continuous conduit sections longer than 100'-0" for premises conduits. For runs that total more than 100'-0", insert junction or pull boxes so that no continuous run between pull boxes is greater than 100'-0".

I. Penetrations

1. All conduit penetrations shall comply with all applicable fire codes.
2. All conduit penetrations in fire-rated walls or floors shall be sealed and fire-proofed to meet or exceed the designed rating of the penetration area.

2.5 BASKEY TRAY

- A. Basket tray systems are defined to include, but are not limited to, straight sections of basket trays, bends, tees, elbows, reducers, crosses, wyes, vertical bends, up/down tees, cable support fittings, drop-outs, supports and accessories.
- B. Install all tray types utilizing manufacturer recommended installation instructions and applicable standards.
- C. Load basket tray and cable runway in accordance with manufacturer requirements and applicable standards.
- D. Basket Tray Materials
 1. Aluminum
 2. Pre-galvanized Steel
 3. Hot-dip Galvanized Steel
 4. Stainless Steel
 5. Yellow Zinc Dichromate
 6. Pre-Galvanized Zinc
 7. Electro-Galvanized Zinc
- E. Basket trays shall have sufficient depth and width so as not to exceed a maximum 50% fill ratio, including 20% capacity for anticipated growth.
- F. All straight sections shall be supplied in minimum 8'-0" lengths, except where shorter lengths are permitted to facilitate tray assembly lengths.

2.6 HANGERS AND SUPPORT

- A. Steel support brackets shall be galvanized steel and capable of supporting a minimum of 200 lbs with a safety factor of 3.
- B. Steel support brackets shall have a removable galvanized steel retaining strap.
- C. Steel support brackets shall accept 0'-3/8" (10mm) threaded rod for attachment to building structure or sub structure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 270000.

3.2 PREPARATION

- A. Refer to Section 270000.
- B. Verify system is properly sized for cables before installation.
- C. Verify that the manufacturer recommended loads are not exceeded.
- D. Verify general routing and coordinate locations with other trades before installation. Layout cable runs in advance to determine quantities of cable to be installed along pathways, and to ensure non-interference from other trade installations.

3.3 INSTALLATION

- A. Refer to Section 270000.
- B. Cable Hooks
 - 1. Provide cable hook (j-hook) cable support system for horizontal and/or riser cabling in accessible ceiling space. Assemblies shall be complete with mounting hardware.
 - 2. Provide threaded rod for supporting hangers when hanging from floor deck and deck members.
 - 3. Follow manufacturers fill capacities.
 - 4. Locate cable hooks on 4' to 5' centers to adequately support and distribute the cable's weight.
 - 5. Suspended cables shall be installed with at least 0'-3" of clear vertical space above the ceiling tiles and support channels.
 - 6. For larger quantities of cables, provide special supports that are specifically designed to support the required cable weight and volume.
 - 7. Do not support pathways or cables with the ceiling suspension system or use electrical, plumbing, or other pipes for support.
 - 8. Cable supports shall be permanently anchored to building structure or substrates. Provide attachment hardware and anchors designed for the structure to which attached, and that are suitably sized to carry the weight of the cables to be supported.

9. Secure and support exposed horizontal cable at intervals not exceeding 5'-0" and not less than 1'-4" (16") from cabinets, rack pole, boxes, fittings, outlets, racks, frames, and terminals.
10. Cable sag between vertical supports for horizontal pathway shall not exceed 0'-6". Provide at least 0'-3" cable sag between supports.
11. Painted J-hooks shall meet or exceed NEC requirements for the environment in which the product is installed.

C. Conduit and Pull Boxes

1. The Contractor shall route the conduit in approximate locations unless drawing is dimensioned for precise placement.
2. Conduit cuts shall be square. Ream ends of burrs, and remove metal shavings and cutting lubricants before conduit is connected to the conduit system.
3. For conduit embedded in concrete, coat threaded connections in conduits with colloidal rust and corrosion inhibitor and sealant. Conduit must be clean and dry and must pass standard sizing test after concrete is poured.
4. Cap unused conduits with watertight caps.
5. Make conduit connections with appropriate fittings and tighten securely.
6. Use appropriate tools to install PVC coated conduit; avoid damage to exterior coating.
7. Install liquid-tight flexible metal conduit where exposed to weather, water, or other liquids.
8. Use IMC, PVC conduit, or rigid galvanized steel conduit in underground installations.
9. The Contractor shall provide fabric innerduct in all underground conduits, as indicated on the drawings.
 - a) The Contractor shall use pre-lubricated, woven polyester, low friction, and high abrasion resistant fabric.
 - b) The Contractor shall be trained for proper installation technique by the innerduct manufacturer. The Contractor shall coordinate with the owner to demonstrate that pull ropes in each inner duct cell move freely from end to end.

D. Cable Tray and Cable Runway

1. Cut wire basket tray members square with approved cable tray cutting tool as to not leave sharp edges at cut point. Remove burrs and smooth the ends before the cut is connected to wire-mesh tray system.
2. Ensure that standard splices are designed to have less than 1 milliohm (0.0001 Ω) of resistance between connections and provide bonding between sections. Painted wire mesh tray requires the outer mask of the non-conductive surface be removed at each end of the tray prior to installing the splice to provide continuity between painted tray sections.
3. Threaded rod (minimum 0'-½" diameter) or equivalent and slotted channel shall be used for hanging cable tray between floor deck and deck members

E. Fiber Support:

1. Support vertical fiber optic cable with basket weave wire/cable grips. Support fiber riser with single weave support grip with a single offset eye.
2. Mount/attach pulling eye to a wall or ceiling deck secured hook to support/provide strain relief to riser cable. Provide a minimum 3'-0" loop of fiber prior to entering fire stopped floor sleeve.
3. Where required coil up slack fiber cable into pull box and secure with single weave support grip.

F. Clearances

1. A minimum of 1'-0" access headroom shall be provided above a cable tray. Ensure that other building components do not restrict access to the cable trays from the sides.
2. Power outlets shall not be installed in or mounted to cable tray or cable runway.
3. Provide 3'-0" of unencumbered space for every 10'-0" segment of tray.
4. Cable tray clearances
 - a) Motors or transformers: 4'-0"
 - b) Power cables and conduit: 1'-0"
 - c) Fluorescent lighting: 0'-5"
 - d) Halide lights: 1'-0"
 - e) Above the ceiling tiles: 0'-3"
 - f) Access above and on one side of the cable tray: 1'-0"

3.4 FIELD QUALITY CONTROL

- A. Test system to ensure electrical continuity of bonding and grounding connections.
- B. Ensure compliance with specified maximum ground resistance.
- C. Refer to NFPA 70B Chapter 18 for testing and test methods.

3.5 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.
- B. Wipe clean all cable trays and apply appropriate manufacturer's paint to areas that have been scratched.

END OF SECTION

SECTION 270810

OPTICAL FIBER TESTING AND MEASUREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Forms, Conditions of the Contract, including Construction Manager/General Contractor (CM/GC) Agreement, Exhibits and other Specification Sections that apply to this section.

1.2 SCOPE OF WORK

- A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete and proper test measurements of the installed optical fiber cabling.
- B. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the optical fiber testing with other applicable trades.
- C. In addition to the test regiment detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.
- D. The contractor shall provide all test measurement results two (2) weeks prior to substantial completion in manifest spreadsheet format and native file format from the test instrument. Software shall also be provided to view the native results.

1.3 SCOPE

- A. Test measurements shall be carried out in accordance with the Tier 2 specification of ANSI/TIA-568-C.0, Annex E, plus an image capture of connector end-faces. Tier 2 testing is a higher level of testing that provides qualitative measures of the installed condition and performance of the cabling system and its components. Tier 2 testing includes length measurement, attenuation measurement, verifying polarity (using an optical loss test set (OLTS) and obtaining a trace and event table of the fiber with an optical time domain reflectometer (OTDR). OTDR traces are used to evaluate the installed cabling for anomalies and assuring uniformity of cable attenuation and connector insertion loss.
- B. Testing shall be performed on each optical fiber cabling link (adapter to adapter).
- C. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode (850nm and 1300nm) and single mode links (1310nm and 1550nm), OLTS length measurements for multimode and single mode links, OTDR traces and event tables for multimode and single mode links, and image captures of connector end-faces.

1.4 Definitions

- A. Optical fiber cabling link: A fiber with an adapter on each end.

1.5 QUALITY ASSURANCE

- A. Refer to Section 270000.
- B. Trained technicians who have successfully attended an optical fiber testing training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - 1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
 - 2. Manufacturer of the test equipment used for the field certification.
 - 3. Training organizations (e.g., BICSI, A Telecommunications Association).
- C. The Owner or the Owner's representative shall be invited to witness, review or both witness and review field-testing.
 - 1. The Owner or the Owner's representative shall be notified of the testing start date, five (5) business days before testing commences.
 - 2. The Owner or the Owner's representative will select a random sample of 5% of the installed links and test that sample. The measured results obtained from the random sample shall be compared to the data provided by the contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor under supervision of the Owner or Owner's representative shall repeat 100% of the testing at no cost to the Owner.

1.6 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for the fiber optic field-test instruments including optical loss test sets (OLTS), optical time domain reflectometer (OTDR) and end face inspection capture device.
- B. A schedule (list) of all optical fibers to be tested identified per UT Administration Office specifications.
- C. Sample test reports.

1.7 Acceptance of test results

- A. Link attenuation measurement and allowance calculation
 - 1. The measured link attenuation shall be less than the link attenuation allowance. The link attenuation allowance is calculated as:

$$\text{Link Attenuation Allowance (dB)} = \text{Cable Attenuation Allowance (dB)} + \text{Connector Insertion Loss Allowance (dB)} + \text{Splice Insertion Loss Allowance (dB)}$$

Where:

$$\text{Connector Insertion Loss Allowance (dB)} = \text{Number of Connector Pairs} \times 0.4\text{dB}$$

$$\text{Splice Insertion Loss Allowance (dB)} = \text{Number of Splices} \times 0.15\text{dB}$$

$$\text{Cable Attenuation Allowance (dB)} = \text{Maximum Cable Attenuation Coefficient (dB/km)} \times \text{Length (km)}$$

Optical fiber cable attenuation performance

Optical fiber and cable type ²	Wavelength (nm)	Maximum attenuation (dB/km)
62.5/125 μ m Multimode (OM1)	850	3.5
	1300	1.5
50/125 μ m Multimode (OM2)	850	3.5
	1300	1.5
850 nm Laser-Optimized 50/125 μ m Multimode (OM3)	850	3.5
	1300	1.5
50/125 μ m Multimode (OM4)	850	3.5
	1300	1.5
Single-Mode Indoor-Outdoor (OS1) (OS2) ³	1310	0.5
	1550	0.5
Single-Mode Inside Plant (OS1) (OS2) ³	1310	1.0
	1550	1.0
Single-Mode Outside Plant (OS1) (OS2) ³	1310	0.5
	1550	0.5

- B. All installed cabling links shall be field-tested and pass the link attenuation measurement and allowance calculation and OTDR analysis. Any optical fiber link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.
- C. Individual connector, splice and fiber insertion loss shall be evaluated using the OTDR trace. These components shall meet or exceed the values in 1.7, A,1.

PART 2 - PRODUCTS

1.1 OPTICAL FIBER CABLE Testers

- A. The field-test instrument shall be within the calibration period recommended by the manufacturer.
- B. The field-test instrument shall contain the most recent software and firmware provided by the manufacturer prior to testing.
- C. Optical loss test set (OLTS)
1. The OLTS shall be capable of providing length measurement of the fiber under test.
 2. Multimode optical fiber light source
 - a. Provide dual LED light sources with central wavelengths of 850 nm (± 30 nm) and 1300 nm (± 20 nm)
 - b. Output power of -20 dBm minimum.
 - c. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (see Part 3, 3.2, C, 1, c) with a Category 1 light source.
 3. Singlemode optical fiber light source
 - a. Provide dual laser light sources with central wavelengths of 1310 nm (± 20 nm) and 1500 nm (± 20 nm).

- b. Output power of -10 dB minimum.
 - 4. Power Meter
 - a. Provide 850nm, 1300nm and 1500nm wavelength test capability.
 - b. Power measurement uncertainty of ± 0.25 dB.
 - c. Store reference power measurement.
 - d. Save at least 100 results in internal memory.
 - e. PC interface (serial or USB).
 - 5. Acceptable manufacturers, models:
 - a. Fluke Networks, OptiFiber (OLTS and OTDR combined)
 - b. Fluke Networks, DTX (OLTS; MFM2, SFM2)
 - c. Corning Cabling Systems OTS-613QD (OLTS)
 - d. Exfo, FOT-600 OLTS (OLTS)
 - e. Owner-approved equivalent
- D. Optical Time Domain Reflectometer (OTDR)
 - 1. Shall have a bright, color transmissive LCD display with backlight.
 - 2. Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
 - 3. Internal non-volatile memory and removable memory device with at least 16 MB capacity for results storage.
 - 4. Serial and USB ports to transfer data to a PC.
 - 5. Multimode OTDR
 - a. Wavelengths of 850 nm (± 20 nm) and 1300 nm (± 20 nm).
 - b. Event dead zones typically of 0.5 m at 850 nm and 1.3 m at 1300 nm.
 - c. Attenuation dead zones 4.5 m at 850 nm and 10.5 m at 1300 nm.
 - d. Distance range 3 km at 850 nm and 7 km at 1300 nm.
 - e. Dynamic range 15 dB at 850 nm and 14 dB at 1300 nm.
 - 6. Single-mode OTDR
 - a. Wavelengths of 1310 nm (± 25 nm) and 1550 nm (± 30 nm).
 - b. Event dead zones typically of 1 m at 1310 nm and 1 m at 1550 nm.
 - c. Attenuation dead zones typically of 8 m at 1310 nm and 8 m at 1550 nm.
 - d. Distance range at least 60 km.
 - e. Dynamic range 26 dB at 1310 nm and 24 dB at 1550 nm.
 - 7. Acceptable manufacturers, models:
 - a. Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image capture)
 - b. Fluke Networks, DTX (QUAD-OTDR)
 - c. Corning Cabling Systems, OV-1000 OTDR
 - d. Exfo, FTB-150 OTDR
 - e. Approved equivalent
- E. Fiber Microscope
 - 1. Magnification of 250X or 400X for end-face inspection
 - 2. Video camera and display showing magnified end-face image.
 - 3. Camera probe tips permitting inspection through adapters.
 - 4. Capable of saving end-face image.
 - 5. Acceptable manufacturers, models:
 - a. Corning Cabling Systems, VIP-CCO-K17
 - b. Fluke Networks, OptiFiber (OLTS and OTDR combined with end face image capture)
 - c. Approved equivalent
- F. Administration
 - 1. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
 - 2. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

PART 3 - EXECUTION

1.1 General

- A. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
NOTE – A visible fault locator (VFL) normally uses a Class 2 or 3 light source and should not be directly viewed. Safe usage of the tool requires indirect viewing of the light source by pointing the end of the fiber at an adjacent surface (or introducing another surface in front of a fixed mounted connector) until the presence of light is determined.
- B. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.
- C. Dust caps shall be placed on fiber end faces or adapters for each optical fiber link after all testing is complete on the fiber link.
- D. Testing shall be performed in accordance with ANSI/TIA-568-C.0 Annex E, Tier 2 testing on each cabling segment (i.e., verify polarity, measuring length, OLTS attenuation measurement, and OTDR trace).
- E. In addition to Tier 2 testing of ANSI/TIA-568-C.0 Annex E, an image of each fiber optic connector end face shall be taken, recorded and provided as part of the records.
- F. Optical fiber link test results from the OLTS, OTDR and end face image shall be recorded in the memory of the field-test instrument.
- G. Each optical fiber test shall be uploaded to a PC in which the administrative documentation (reports) shall be generated.
- H. The records for each test shall be provided to the owner a minimum of two weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractor's use.

1.2 OPTICAL FIBER TESTING

- A. Polarity
 - 1. For duplex connector systems, polarity shall be verified. The polarity shall be verified with an OLTS while performing attenuation tests.
- B. Length measurement
 - 1. Each optical fiber link shall be measured for its length. The fiber length may be obtained by a capable OLTS or by an OTDR.
- C. Attenuation measurement (OLTS)
 - 1. General
 - a. Optical sources shall be turned on for a minimum of 5 minutes prior to referencing.
 - b. Test jumpers shall be reference quality and between 1m and 5m in length.
 - c. Where mandrels are used, secure the mandrel to the light source by some means such as a cable tie or tape. Care should be taken to ensure that the fiber jacket is not deformed or damaged when using a cable tie or tape.
 - d. The light source shall be referenced to the meter a minimum of twice daily (i.e., in the morning and noon).

- e. Fiber test jumpers shall be of the same core size as the cabling under test (e.g., singlemode to singlemode, 62.5µm multimode to 62.5µm multimode, 50µm multimode to 50µm multimode). Additionally the test jumpers shall meet the performance specifications of the fiber under test and that of the test instrument manufacturer.
 - f. Fiber test jumpers shall be cleaned prior to connection to the test instrument. After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the test instrument.
 - g. The end of the fiber test jumper that will connect to the fiber link to be tested, the adapters and fiber under test shall be cleaned immediately prior to each fiber being tested. After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the fiber under test.
 - h. The test jumper connected to the source shall not be removed after referencing so as not to adversely influence the attenuation measurement. Removal and reattachment of the test jumper connection from the source may affect the referenced power level. Re-referencing is to be performed if the test jumper is disconnected from the light source.
 - i. Singlemode optical fiber links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper.
 - j. Multimode optical fiber links shall be tested at 850 nm and 1300 nm in accordance with ANSI/TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - k. Multimode and singlemode optical fiber links shall be measured and reported for attenuation in each direction and attenuation bi-directionally (averaged in both directions). The measurements shall be less than or equal to the link attenuation allowance calculation (see Part 1, 1.7, A.).
2. Steps to measure and calculate optical fiber link attenuation include a) verifying test jumper quality; b) setting the reference; c) measuring link attenuation; and d) calculating link attenuation.

This example below describes the process when testing multimode fiber with the test jumper connected to the source having five non-overlapping wraps of multimode fiber on a mandrel. The procedure is also applicable to single-mode cabling, however, the five non-overlapping wraps of multimode fiber would be replaced with a single 30 mm (1.2 in) diameter loop of single-mode fiber.

- a. Verifying test jumper quality
 - 1) Test jumpers shall be tested for quality prior to use as a test jumper. See example below.

To verify that the test jumpers are in acceptable condition, first reference the light source to the optical power meter (see figure 1). Disconnect test jumper (J1) from the power meter (only) and insert a second test jumper (J2) by connecting it to the power meter and to (J1) with a mating adapter (see figure 2) and record the measurement. Disconnect both ends of J2, interchange the ends, and reconnect it and record the measurement. The resulting measurements, P_{verify} , should be within the appropriate connector loss specification. For example, if the connector used is specified at 0.32 dB, the reading on the power meter should be within 0.32 dB of P_1 .

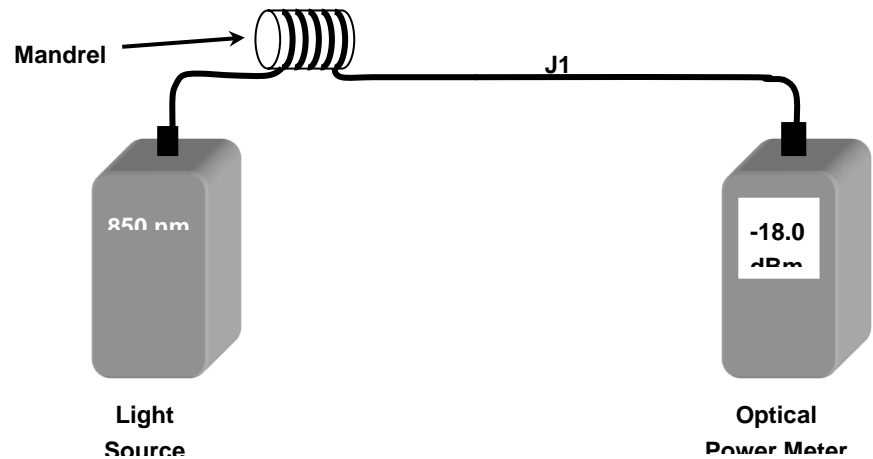


Figure 1 – Example of OLTS reference measurement (P_1) with one test jumper (multimode)

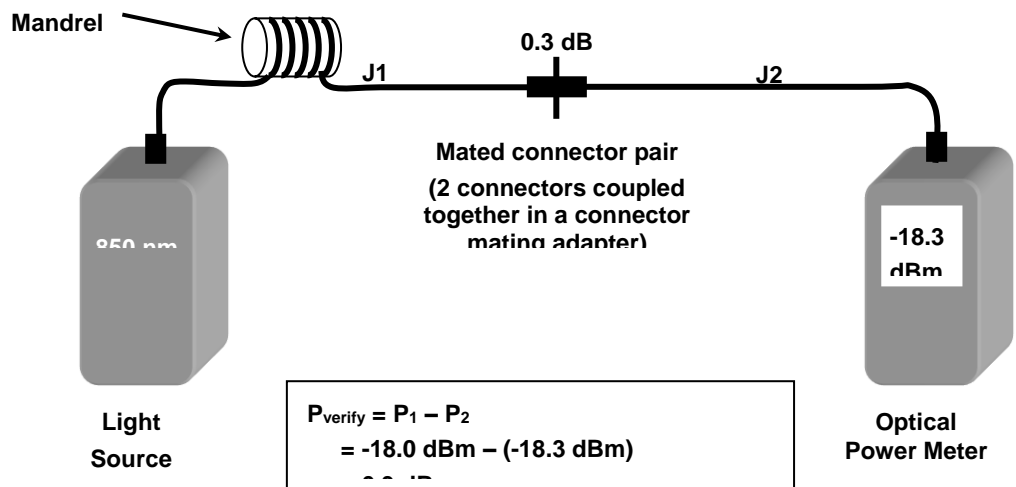


Figure 2 – Example of a measurement (P_2) when verifying OLTS test jumpers (multimode)

- b. Setting the reference
 - 1) One test jumper (J1) is to be connected between the light source and the power meter and a reference measurement taken (P_1 [dBm]). When testing a multimode optical fiber link, a mandrel wrap shall be applied to the test jumper (J1) prior to setting the reference and for all subsequent measurements. When testing a singlemode optical fiber link, a single 30 mm (1.2 in) diameter loop shall be applied to the test jumper (J1) prior to setting the reference and for all subsequent measurements.

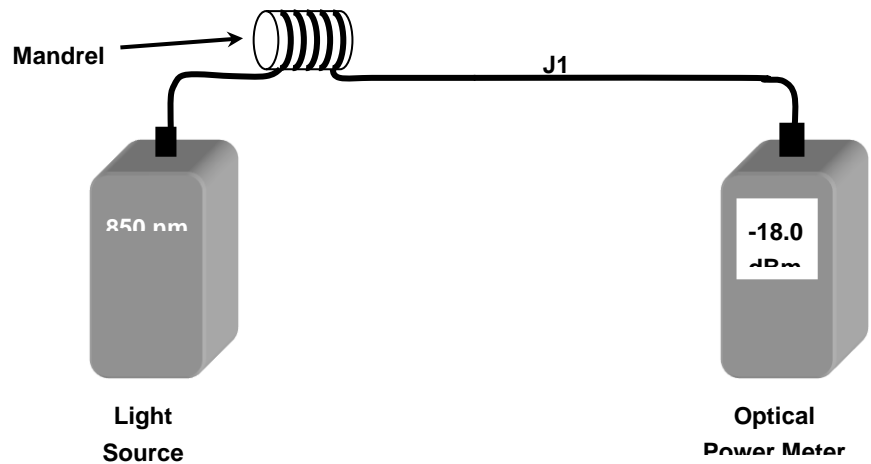


Figure 3 – Example of OLTS reference measurement (P_1) with one test jumper (multimode)

- c. Measuring link attenuation
 - 1) Connect the end of test jumper (J1) (source end) to one end of the link, and connect an verified test jumper (J2) between the other end of the link and the meter (see figure 4). The optical power reading is P_2 (dBm).

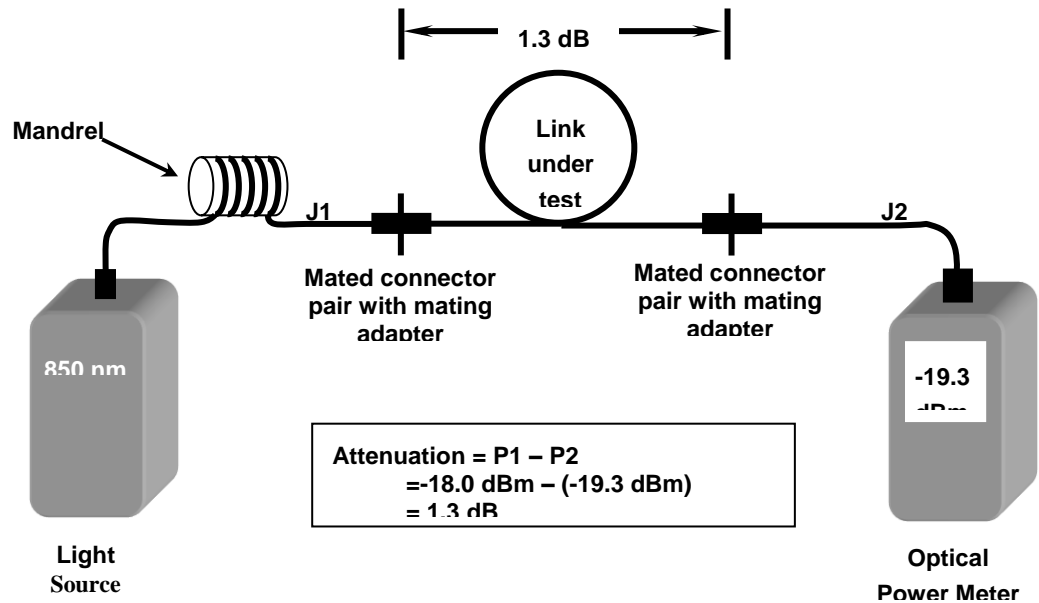


Figure 4 – Example of a multimode link attenuation measurement (P_2)

- 3. Link attenuation measurement and allowance calculation
 - a. The measured link attenuation shall be less than the link attenuation allowance.

D. Optical fiber end face image

1. An image of each optical fiber end face shall be taken and recorded after Tier 2 testing of the optical fiber link is completed. The end face image shall be captured at either 250X or 400X.
- E. OTDR trace
1. An OTDR trace shall be taken of each optical fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss. Multimode fiber traces shall be taken at 850nm and 1300nm. Singlemode fiber traces shall be taken at 1310nm and 1550nm.
 2. A launch cable to the length specified by the manufacturer of the OTDR shall be installed between the OTDR and the first link connection. The launch cable shall be of the same fiber type as the link under test.
 3. A receive cable shall be installed after the last link connection to be part of the OTDR trace. The receive cable shall be at least 100m (328ft) in length and of the same fiber type as the link under test.
 4. Selectable parameters affecting the OTDR measurement may include the test source wavelength, pulse duration or signal strength, length range, backscatter coefficient, signal averaging (time or count) and the group index of the fiber (also known as the index of refraction or the refractive index). The display shall be adjusted to view the region of interest on the trace on both the horizontal and vertical axes.

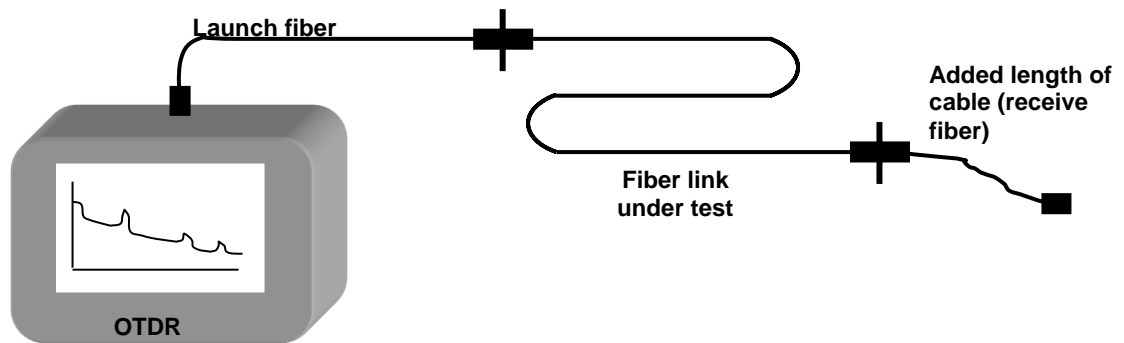


Figure 5 – OTDR setup illustration of fiber link testing

1.3 Administration

- A. Test results documentation
1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument".
 2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period. The contractor shall retain a copy to aid preparation of as-built information.
 3. The records for each test shall be provided to the owner a minimum of two weeks prior to substantial completion in Excel format and the native format to the test instrument. The Owner can supply an Excel spreadsheet template upon request for the contractors use.
 4. Circuit IDs reported by the field-test instrument shall match the label ID specified by the Owner.
 5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
 - a. The identification of the customer site as specified by the end-user
 - b. The name of the standard selected to execute the stored test results
 - c. The name of the test personnel

- d. The date and time the test results were saved in the memory of the tester
- e. The manufacturer, model and serial number of the field-test instrument
- f. The version of the test software and the version of the test standards database held within the test instrument
- g. The value of the 'index of refraction' used for length calculations
- h. The fiber identification number
- i. The length for each optical fiber calculated by the OLTS.
- j. Test results to include OLTS attenuation link and channel measurements at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
- k. Test results shall be submitted to include OTDR link and channel traces and event tables at 850 nm and 1300 nm for multimode cabling, and at 1310 nm and 1550 nm for singlemode cabling and the margin (difference between the measured attenuation and the test limit value).
- l. The length for each optical fiber calculated by the OTDR.
- m. The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
- n. A picture or image of each fiber end-face

End of Section

SECTION 271100

COMMUNICATIONS ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes basic communications and equipment room design requirements and fittings including:
 - 1. Equipment cabinets, racks, frames and enclosures
 - 2. Cable management and ladder racks
 - 3. Telecommunications service entrance pathways
 - 4. Rack mounted power protection and power strips
- B. Related Sections
 - 1. Section 260000 Electrical (including related sub-sections)
 - 2. Section 270000 Communications
 - 3. Section 270526 Grounding and Bonding for Communications Systems
 - 4. Section 270528 Pathways for Communications
 - 5. Section 270810 Fiber Optic Testing and Measurements
 - 6. Section 271300 Communications Backbone Cabling
 - 7. Section 271500 Communications Horizontal Cabling
 - 8. Section 274100 Audio-Visual Systems
 - 9. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts
 - 1. Refer to section 270000.
- D. Codes and Standards (Most recent editions or as required in contract)
 - 1. Refer to section 270000.
- E. Communications rooms must be dedicated to designated equipment and services:
 - 1. Space shall not be used for storage of equipment not related to designated equipment and services.
 - 2. Hazardous or corrosive materials shall not be stored in the space.

3. Piping, ductwork and distribution of power, not related to designated equipment and services shall not pass through or be located within the space.
 - a) Foreign piping such as water pipes, steam pipes, soil pipes, sanitary drains, storm drains, A/C ducts, and other unrelated systems utilized for or containing liquids, or gases shall not be installed or pass through communication rooms.
 - b) With the exception of fire sprinklers, all water pipes shall be routed around communications room.
- F. Each communication room shall be equipped with fire detection, fire-extinguishing system and prevention devices. Connect detection devices to base building fire alarm system. A minimum of one (1) smoke detector shall be installed in each communications room.
- G. Walls shall be covered with 0'- $\frac{3}{4}$ " X 4'-0" X 8'-0" AC-grade plywood backboard 1'-0" AFF (smooth side to interior of room mounted vertically), capable of supporting mounted hardware and equipment.
 1. Plywood shall be affixed to the studs in the walls with screws that penetrate the studs a minimum of 0'-1", are spaced not greater than 1'-6" (18") apart in each stud, and with screws 0'-0" from the top and bottom of plywood.
 2. Plywood shall be sealed against the wall and painted on all exposed sides with two coats of flat white non-reflective paint.
 3. If applicable fire-treatment verification stamps on plywood shall be left unpainted to be readable.
- H. Communications room walls shall extend from floor slab to ceiling deck, with no drop ceilings installed.
- I. Cable tray or ladder rack should be used to distribute cables between rooms through finished wall penetrations.
- J. Cable ladder rack should be used to distribute cables within rooms, complete with cable bend limiters (drop outs).
- K. To reduce static, floors should not have carpet, but be sealed concrete to prevent concrete dust from forming.
- L. Communications rooms shall have only one lockable entrance door, a minimum of 3'-0" wide and 7'-0" high, that opens towards the outside of the room, and does not open into another room.
 1. Doors shall be provided with a lockset for the appropriate technology key with pinned hinges and anti-pry guards.
 2. Doors should have no windows or door seals.
 3. Communications rooms should have no exterior identifying markings.
- M. Mechanical
 1. Install monitoring sensors with dedicated environmental controls operating 24 hours a day, 365 days a year in the communications rooms.
 2. Provide ventilation in the communications rooms to dissipate heat generated by active devices.
 3. Temperature and Humidity requirements:

- a) Maintain communication rooms at an average of 60°F to 70°F, with a relative non-condensing humidity of 30% to 50%.
- b) The temperature range should be maintained within $\pm 9^\circ$

N. Plumbing

- 1. If “wet” fire suppression is used, install wire cages on sprinkler heads to prevent accidental operation.
- 2. Do not place sprinkler heads over equipment or cabling. In the event of a leak this will protect the equipment and cabling.
- 3. Drainage troughs are also recommended for leakage protection.

O. Electrical

- 1. One manufacturer’s product is recommended for each type of installation. The mixing of different manufacturer products for one item is not acceptable.
- 2. No electrical feeders/branch circuits shall be placed in or run through any communications room except as required to service those rooms.
- 3. The Contractor shall install a slot (a UL-approved fire-rated assembly) to accommodate cable runway entry from corridor and a fire-retardant system (bricks, boards, mechanical, etc). The formed slot shall have no burrs or sharp edges. This opening in the wall will be used to pass data and voice cabling from the corridor cable tray into the communications room.
- 4. The Contractor shall provide uniform illumination of at least 50 foot-candles (fc) 3’-0” AFF for communications rooms located a minimum of 8’-6” AFF.
 - a) Light fixtures in communications rooms are to be positioned for maximum lighting. Do not install over cable tray, ladder rack, or 1’-7” (19”) standing racks.
 - b) Provide enough power receptacles to support equipment and service. Coordinate power requirements of active equipment with electrical designer.

P. Relay Racks

- 1. 1’-7” (19”) X 7’-0” relay racks are to be used for mounting and termination of inter-building and intra-building fiber optic/ copper cables and components.
 - a) The racks shall have adequate horizontal and vertical cable management for the 8P8C patch panels and switches.
 - b) Racks with active electronics shall have rack mounted power strips.

1.3 SUBMITTALS

- A. Refer to section 270000.

1.4 QUALITY ASSURANCE

- A. Refer to section 270000.
- B. Product Standards

1. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of telecommunications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.
2. Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to section 270000.
- B. Coordinate layout and installation of equipment with owner's communications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1.6 PROJECT/SITE CONDITIONS

- A. Refer to section 270000.

1.7 WARRANTY

- A. Refer to section 270000.
- B. At the start of the project, contractor shall register the project with the manufacturer to help insure and facilitate manufacturer's warranty process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. 1'-7" (19") Floor-Mounted Equipment Racks with Vertical Managers
 1. Siemon – RS3-07-S
 2. Owner approved alternate
- B. Horizontal Rack-Mount Cable Management
 1. ~~Siemon RS3-RWM4-2~~
 2. **Siemon RS3-RWM-2**
 3. Owner approved alternate
- C. Equipment Cabinet, Floor-Mounted (42U with doors and sides)
 1. APC NetShelter
 2. Owner approved alternate
- D. Labeling
 1. Refer to section 270000.
- E. Firestopping

1. Refer to section 270000.

2.2 ACCESSORIES

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 270000.

3.2 PREPARATION

- A. Refer to section 270000.
- B. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
- C. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.3 INSTALLATION

- A. Refer to section 270000.

3.4 FIELD QUALITY CONTROL

- A. Refer to section 270000.

3.5 CLEANING

- A. Refer to section 270000.

3.6 ACCEPTANCE

- A. Refer to section 270000.

END OF SECTION

SECTION 271300

COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the backbone cabling portion of a structured cabling system including:
 - 1. Fiber backbone cabling
 - 2. Splicing
 - 3. Termination and patch cables
- B. Provide all backbone cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in Communications rooms.
- C. Related Sections
 - 1. Section 260000 Electrical (including related sub-sections)
 - 2. Section 270000 Communications
 - 3. Section 270526 Grounding and Bonding for Communications Systems
 - 4. Section 270528 Pathways for Communications
 - 5. Section 270810 Optical Fiber Testing and Measurements
 - 6. Section 271100 Communications Equipment Room Fittings
 - 7. Section 271500 Communications Horizontal Cabling
 - 8. Section 274100 Audio-Visual Systems
 - 9. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts
 - 1. Refer to section 270000.
- D. Codes and Standards (Most recent editions or as required in contract)
 - 1. Refer to section 270000.

1.3 SUBMITTALS

- A. Refer to section 270000.

B. Cable Pulling Plan

1. The contractor shall submit a cable pulling plan prior to installation.
2. Submittal requirements:
 - a) Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
 - b) Indicate contents of each conduit.
 - c) Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
 - d) Include detail and schedule showing the construction sequence of communications rooms.
 - e) Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the engineer.

C. Splice Plan

1. The contractor shall submit shop drawings indicating the intended cable splice points, mounting method and equipment list prior to installation

D. Cable Testing Plan

1. Refer to Section 270000.

E. Cable Testing Reports

1. Refer to Section 270000.

1.4 QUALITY ASSURANCE

- A. Refer to section 270000.
- B. Cable splicing personnel shall have a minimum of five years splicing experience and shall have completed a minimum of five major splicing projects.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to section 270000.
- B. Storage temperature range: -40°F to 149°F (-40°C to 65°C)
- C. Fiber cables shall be shipped on reels in lengths as specified with a minimum overage of 10%:
 1. The cable shall be wound on the reel so that unwinding can be done without kinking the cable.
 2. Two meters of cable at both ends of the cable shall be accessible for testing.
 - a) All fiber shall be tested on the reel for continuity and distance compliance before installation.
 3. Each reel shall have a permanent label attached showing length, cable identification number, cable size, cable type, attenuation, bandwidth, and date of manufacture.

- a) Labels shall be water resistant and the writing on the labels shall be indelible.

1.6 PROJECT/SITE CONDITIONS

- A. Refer to section 270000.

1.7 WARRANTY

- A. Refer to section 270000.

1.8 MAINTENANCE AND SUPPORT

- A. Refer to section 270000.

PART 2 - PRODUCTS

2.1 ACCEPTABLE FIBER CABLE MANUFACTURERS

- A. ~~Armored OSP (Outside Plant) cable with rodent resistant insulation~~
 - 1. ~~Corning~~
 - 2. ~~Owner approved alternate~~
- B. Backbone **Armored** Plenum Rated ~~(Riser)~~ cable **(24-Strand Single Mode)**
 - 1. ~~Corning — 12 Strand Single Mode 012E88-33131-29~~
 - 2. Corning – 24 Strand Single Mode 024E88-33131-29
 - 3. ~~Corning — 12 Strand 62.5um Multi Mode 012K88-33130-29~~
 - 4. ~~Corning — 24 Strand 62.5um Multi Mode 024K88-33130-29~~
 - 5. Owner approved alternate

2.2 ACCEPTABLE COMPONENT MANUFACTURERS

- A. Fiber Connectors, (SC)
 - 1. Corning
 - 2. Owner approved alternate
- B. Fiber Duplex Patch Cables (Type SM)
 - 1. ~~Leviton~~
 - 2. ~~CommScope~~
 - 3. ~~Berk-tek~~
 - 4. Corning
 - 5. ~~Panduit~~
 - 6. Owner approved alternate
- C. ~~Fiber adapter panels (6-Port)~~

1. ~~OCC Part 6012DSC~~
2. ~~Owner approved alternate~~

D. Fiber adapter panels (12-Port)

1. OCC – 12F SM FAP 6112SMDSC
2. ~~OCC – 12F MM FAP 6112MMDSC~~
3. OCC – FAP Blank 600
4. Owner approved alternate

E. Fiber Termination Shelf (Rack-Mounted)

1. ~~OCC – RTC2U-6APB (2RU enclosure)~~
2. OCC – RTC4U-12APB (4RU enclosure)
3. Owner approved alternate

F. Labeling

1. Refer to section 270000.

G. Firestopping

1. Refer to section 270000.

2.3 FIBER BACKBONE CABLING

A. Fiber General Requirements

1. Fiber shall be certified to meet all parts of TIA-455 and comply with TIA-492, ANSI/ICEA S-83-596 and ANSI/ICEA S-83-640 and the NEC.
2. Fibers shall have D-LUX coating or approved equivalent to ensure color retention, minimize micro bending losses and improve handling. The coating shall be mechanically strippable.
3. Cable installed in plenums or air-handling spaces shall meet UL 910 and shall be marked OFNP (optical fiber non-conductive plenum) in accordance with the NEC.
 - a) Plenum Fiber rated cable consisting of multiple fibers shall have a Plenum PVC outer jacket.
 - 1) Each group of fibers shall have a color-coded Low Smoke PVC buffer.
 - 2) The buffered fibers are organized in subunits of fibers, reinforced with aramid yarn for extra strength and surrounded with a color-coded low smoke tube.
 - b) Within the premises, all fiber shall be placed in plenum rated innerduct the entire length of the cable for protection. Use manufacturer plenum rated couplings for all connections.
4. Riser cable shall meet UL 1666 and be marked OFNR (optical fiber nonconductive riser) in accordance with the NEC.
 - a) Non-plenum, riser rated cable consisting of multiple fibers, shall have an orange, Polyvinyl Chloride (PVC) outer jacket.
5. OSP (Outside Plant) Fiber

- a) Stranded loose tube dielectric fiber cable shall be utilized for underground conduit, direct buried, or aerial applications.
 - b) Underground cable, including cable installed in conduits or duct banks, shall contain an additional moisture barrier in the form of a flooding compound.
 - c) All OSP fiber strength members shall be dielectric without any metallic elements.
6. Fiber conductors shall follow standard color code schemes. Fiber numbers and binders shall correspond to the following color codes:
- a) Fiber/Binder No. 1 – blue
 - b) Fiber/Binder No. 2 – orange
 - c) Fiber/Binder No. 3 – green
 - d) Fiber/Binder No. 4 – brown
 - e) Fiber/Binder No. 5 – slate
 - f) Fiber/Binder No. 6 – white
 - g) Fiber/Binder No. 7 – red
 - h) Fiber/Binder No. 8 – black
 - i) Fiber/Binder No. 9 – yellow
 - j) Fiber/Binder No. 10 – violet
 - k) Fiber/Binder No. 11 – rose
 - l) Fiber/Binder No. 12 – aqua
7. Cable Minimum Bending Radius:
- a) During Installation: 20X cable diameter
 - b) After Installation: 10X cable diameter
8. Operating temperature range: -76°F to 185°F (-60°C to 85°C)

B. Single Mode Fiber Requirements

- 1. Fibers shall have dual wavelength capability, transmitting at 1310 and 1550 nm ranges.
- 2. 8.3 μm core
- 3. 125 $\mu\text{m} \pm 1 \mu\text{m}$ cladding diameter
- 4. Cladding non-circularity: = 1%
- 5. Core/cladding concentricity error: = .5 μm
- 6. Colored fiber diameter: 254 $\mu\text{m} \pm 7 \mu\text{m}$
- 7. Maximum Attenuation: 1.0 dB/km at 1310 and 1550 nm (inside premises) and 0.5 dB/km at 1310 and 1550 nm (OSP)
- 8. Minimum Bandwidth: 20 GHz
- 9. The mechanical and environmental specifications for OSP fiber cable shall be in accordance with ANSI/ICEA S-87-640. OSP fiber cables shall be of a water-block construction and meet the requirements for compound flow and water penetration as established by ANSI/ICEA S-87-640. Outdoor cable shall have minimum pull strength of 2670 N (600 lbf).

2.4 COPPER PATCH CABLES

- A. Refer to Section 271500.

2.5 FIBER PATCH CABLES

- A. Verify exact quantities and lengths with Owner prior to purchase
- B. Provide the appropriately-rated (matched to the installed cable plant) Modular Patch Cords for the appropriate location and equipment.
- C. Single Mode patch cables shall be a stepped-index 8.3 μm core with a 125 μm cladding.
- D. Duplex SC connectors shall meet the following specifications:
 - 1. Made and warranted by the manufacturer of the cabling system installed in this project and shall meet or exceed patch cord specifications as outlined in TIA standards.
 - 2. Patch cords shall be in original packaging when presented to the Owner.
- E. Aramid yarn and a jacket of flame-retardant PVC shall cover the fiber cladding.
- F. Single Mode patch cable additional requirements:
 - 1. Return Loss: -50 dB maximum
 - 2. Mated Connector Loss: $\mu = 0.35$ dB, $\sigma = 0.2$ dB
 - 3. Connection Repeatability: 0.20 dB maximum changes per 200 re-connects.
- G. The Single Mode connector (visible portion) and adapter/outlet shall be identified by the color blue.

2.6 LABELING

- A. Refer to Section 271500.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 270000.
- B. Verify the following before proceeding:
 - 1. Conduits, cable trays and pull boxes are properly installed following section 270528
 - 2. Backboards in communications rooms are properly installed following section 271100
 - 3. Grounding system is properly installed and tested following section 270526
 - 4. Liquid-carrying pipes are not installed in or above voice and data system communications rooms.
 - a) Do not proceed with installation in affected areas until removed.

3.2 PREPARATION

- A. Refer to section 270000.
- B. OSP Cable

1. The Contractor shall verify pulling material (pull rope, mule tape, etc.) average breaking strength based on cable type and size, pulling distance and pathway, and other pertinent factors.

3.3 FIBER INSTALLATION

A. Fiber Cable Installation

1. Fiber cable shall be installed in innerduct from near end termination point to far end termination point.
 - a) Only UL-approved plenum-rated innerduct shall be installed in all plenum areas.
 - b) Metallic conduit may be used in lieu of innerduct in plenum-rated ceilings if it is bonded and grounded correctly.
2. Only technicians certified by the product manufacturer shall perform terminations.
 - a) Terminations shall be made in a controlled environment.
 - b) Cables may be assembled off-site, although testing must be completed with the cable in its final installed condition.
 - c) Test optical fiber on the reel for distance and continuity verification before installation.
3. At each location where fiber cable is exposed to human intrusion, it shall be marked with warning tags.
 - a) These tags shall be yellow or orange in color, and shall contain the warning "CAUTION FIBER OPTIC CABLE".
 - b) The text shall be permanent, black, block characters, and at least 0'-1.875" high.
 - c) A warning tag shall be permanently affixed to each exposed cable or bundle of cables, at intervals of not less than 5'-0".
 - d) Any section of exposed cable that is less than 5'-0" in length shall have at least one warning tag affixed to it.

B. Fiber Distribution Center

1. Contractor shall provide sufficient spare adapter plates to fill the appropriate-sized FDC.

3.4 FIBER TERMINATION AND SPLICING

A. Interconnect Units and Distribution Shelves

1. Modular in design and used in fiber interconnection, cross-connection, and splicing applications
2. 1'-7" (19") rack-mountable
3. Accept 12-strand, 24-strand, 48-strand or 72-strand terminations
4. Owner approved industry standard connector

B. Splicing and closures

1. Fiber splice modules shall be utilized for all OSP terminations.
2. The link shall consist of:

- a) Fiber cable
- b) Splice
- c) Splice tray holder/closure
- d) Fiber panel/coupler
- e) Pre-manufactured fiber pigtail with pre-polished fiber connector
- f) Fiber jumper to connect the pigtail-coupled link to the appropriate electronic switch

C. Fiber Fusion Splice

- 1. Fusion splices shall be mounted in protective trays within the closure.
- 2. Fusion splices shall not exceed a maximum optical attenuation of 0.3 dB when measured in accordance with ANSI/TIA-455-34, Method a (factory testing) or ANSI/TIA-455-59 (field testing).
 - a) Fiber splices shall have a minimum return loss of 26 dB for Single Mode
 - 1) Minimum Single Mode return loss for broadband analog video (CATV) applications is 55 dB.

3.5 INSTALLATION REQUIREMENTS

- A. All installation shall be done in conformance with ANSI/TIA-568-B standards, BICSI methods, and industry standard installation guidelines.
 - 1. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
 - 2. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.
 - 3. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- B. The Contractor shall provide service loops for cables terminating in the communications rooms.
 - 1. A 10'-0" service loop shall be provided and secured in a neat and standards-compliant manner above the equipment racks or cable trays unless specified otherwise.
 - 2. This allows for future changes or expansion without installing new cables.
- C. Documentation
 - 1. All cable inventory data documentation shall be submitted in format coordinated with and approved by owner so that data can be incorporated into existing databases.
 - 2. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.
 - 3. Complete cross connect documentation is required. It shall include detailed documentation of each pair of all copper backbone cable and strand of fiber.

3.6 FIELD QUALITY CONTROL

- A. Refer to section 270000.

3.7 COPPER POST-INSTALLATION TESTING

- A. Contractor shall test each pair or strand of every cable prior to acceptance.
- B. Refer to Sections 270000 and 271500.
- C. Copper Test Documentation
 - 1. Refer to Section 271500.

3.8 FIBER POST-INSTALLATION TESTING

- A. Provide all labor, materials, tools, field-test instruments and equipment required for the complete and proper test measurements of the installed fiber cabling.
- B. Contractor shall have successfully attended a fiber testing training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof.
- C. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing.
 - 1. Any testing performed on incomplete systems shall be redone on completion of the work.
- D. Dust caps shall be placed on fiber endfaces or adapters for each optical fiber link after all testing is complete on the fiber link.
- E. Pre-test Submittals
 - 1. Manufacturers catalog sheets and specifications for the fiber cable field-test instruments including
 - a) OLTS (Optical Loss Test Set)
 - b) OTDR (Optical Time Domain Reflectometer)
 - 2. A schedule (list) of all fiber cables to be tested
 - 3. Fiber testing training program certificate
 - 4. Sample test reports
- F. Fiber testing standards
 - 1. The Contractor shall meet or exceed the following standards and guidelines:
 - a) ANSI/TIA-568-C.0 Optical Fiber Transmission/Test Requirements, and Annex E: Optical Fiber Field Test Guidelines (Tier 2)
 - 1) Tier 2 testing is a higher level of testing that provides qualitative measures of the installed condition and performance of the cabling system
 - b) ANSI/TIA-568-B.3 Optical Fiber Cabling Components Standard
 - c) TIA/TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
 - 2. Single Mode requirements

- a) ANSI/TIA-526-7, Method A.1: Optical Power Loss Measurements of Installed Single Mode Fiber Cable Plant-OFSTP-7
- 3. The cable installers shall have a copy of these references in their possession and be familiar with the contents
- G. In order to conform to the overall project event schedule, the contractor shall survey and coordinate the optical fiber testing with other applicable trades.
- H. In addition to the test regiment detailed in this document, the contractor shall notify the Owner of any additional tests that are deemed necessary to guarantee a fully functional system.
 - 1. The contractor shall carry out and record any additional measurement results at no additional charge.
- I. The contractor shall provide all test measurement results two (2) weeks prior to substantial completion in spreadsheet format and native file format from the test instrument.
 - 1. Software shall also be provided to view the native results.
- J. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
 - 1. A visible fault locator (VFL) normally uses a Class 2 or 3 light source and should not be directly viewed.
 - 2. Safe usage of the tool requires indirect viewing of the light source by pointing the end of the fiber at an adjacent surface (or introducing another surface in front of a fixed mounted connector) until the presence of light is determined.
- K. Link attenuation measurement and allowance calculation
 - 1. The measured link attenuation shall be less than the link attenuation allowance. The link attenuation allowance is calculated as:
 - a) $\text{Link Attenuation Allowance (dB)} = \text{Cable Attenuation Allowance (dB)} + \text{Connector Insertion Loss Allowance (dB)} + \text{Splice Insertion Loss Allowance (dB)}$
 - 1) $\text{Connector Insertion Loss Allowance (dB)} = \text{Number of Connector Pairs} \times 0.4\text{dB}$
 - 2) $\text{Splice Insertion Loss Allowance (dB)} = \text{Number of Splices} \times 0.15\text{dB}$
 - 3) $\text{Cable Attenuation Allowance (dB)} = \text{Maximum Cable Attenuation Coefficient (dB/km)} \times \text{Length (km)}$
- L. Fiber Testing Requirements
 - 1. All installed fiber links shall be field-tested and pass the following tests:
 - a) OLTS (Optical Loss Test Set) length and dual wavelength attenuation
 - b) OTDR (Optical Time Domain Reflectometer) traces and event tables
 - 2. OLTS (Optical Loss Test Set)
 - a) The length and attenuation of each installed fiber link shall be measured and documented.

- b) System loss measurements requirements:
 - 1) 850 and 1300 nanometers for Multi-mode
 - 2) 1310 and 1550 nanometers for Single Mode
 - c) Reflective events (connections) shall not exceed 0.75 dB.
 - d) Non-reflective events (splices) shall not exceed 0.3 dB.
 - e) The acceptable link attenuation for Multi-mode horizontal fiber is based on the maximum distance of 295'-0".
 - f) A horizontal link in a network with a consolidation point may be tested using a fixed upper limit for attenuation of 2.75 dB.
 - g) Optical sources shall be turned on for a minimum of 5 minutes prior to referencing.
 - h) Fiber links shall be measured and reported for attenuation in each direction and attenuation bi-directionally (averaged in both directions)
 - i) Polarity shall be verified for duplex connector systems
 - j) Mandrels
 - 1) Mandrels shall be used when testing attenuation of Multi-mode fiber cabling
 - 2) Where mandrels are used, secure the mandrel to the light source by some means such as a cable tie or tape.
 - 3) Care should be taken to ensure that the fiber jacket is not deformed or damaged when using a cable tie or tape.
 - 4) The light source shall be referenced to the meter a minimum of twice daily (i.e., in the morning and noon).
3. OTDR (Optical Time Domain Reflectometer)
- a) An OTDR trace shall be taken of each fiber link in one direction to ensure uniformity of cable attenuation and connector insertion loss
 - b) Testing shall consist of a bi-directional end to end OTDR trace performed per TIA 455-61
 - c) Individual connector, splice and fiber insertion loss shall be evaluated using the OTDR trace.
 - d) Fibers shall be inspected at 250X for Multi-mode and 400X for Single Mode
4. Maximum Attenuation
- a) Single Mode ISP (inside) 1.0 dB/km at 1310 nm and 1550 nm
 - b) Single Mode OSP (outside) 0.5 dB/km at 1310 nm and 1550 nm
5. Test Cords (Jumpers)
- a) Testing of the cabling shall be performed using high-quality test cords of the same fiber type and core size as the cabling under test.
 - 1) OLTS test cords shall be between 3'-3" (1m) and 16'-4" (5m).
 - 2) OTDR testing shall be approximately 328'-0" (100m) for the launch cable and at least 82'-0" (25m) for the receive cable.
 - b) The test jumper, the adapters, and fiber under test shall be cleaned immediately prior to each fiber being tested.

- 1) After cleaning, cleaning solutions shall be given sufficient time to evaporate (approximately 30 seconds) prior to the mating of fiber test jumper to the fiber under test.
6. Test Failure
- a) Any fiber link that fails these requirements shall be diagnosed and corrected.
 - b) Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link meets performance requirements
7. Acceptable Testers
- a) Fluke DTX CableAnalyzer
 - b) Owner Approved equivalent
- M. The Owner or the Owner's representative shall be invited to witness, review or both witness and review field-testing.
1. The Owner or the Owner's representative shall be notified of the testing start date, five (5) business days before testing commences.
 2. The Owner or the Owner's representative will select a random sample of 5% of the installed links and test that sample.
 - a) The measured results obtained from the random sample shall be compared to the data provided by the contractor.
 - b) If more than 2% of the sample results differ in terms of the pass/fail determination, the contractor under supervision of the Owner or Owner's representative shall repeat 100% of the testing at no cost to the Owner.
- N. Test Results
1. The detailed test results documentation data is to be provided in an electronic database for each tested fiber strand and shall contain the following information:
 - a) Identification of the customer site as specified by the end-user
 - b) Name of the test limit selected to execute the stored test results
 - c) Name of the personnel performing the test
 - d) Date and time the test results were saved
 - e) The manufacturer, model and serial number of the test instrument.
 - f) The version of the test software and the version of the test limit database held within the test instrument.
 - g) Fiber identification number
 - h) Length for each optical fiber
 - i) Index of refraction used for length calculation when using a length capable OLTS.
 - j) Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
 - k) Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
 - l) Length for each optical fiber as calculated by the OTDR
 - m) Overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
 - n) Circuit IDs reported by the test instrument should match the specified label ID

3.9 CLEANING

- A. Refer to section 270000.

3.10 ACCEPTANCE

- A. Refer to Section 271500.

END OF SECTION

SECTION 271500

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section of the horizontal cabling portion of a structured cabling system includes:
 - 1. UTP Copper cabling
 - 2. Termination and patch cables
 - 3. Coaxial Cabling
- B. Provide all horizontal cabling, terminating hardware, adapters, and cross-connecting hardware necessary to interconnect all system equipment including equipment located in communications rooms.
- C. Related Sections
 - 1. Section 260000 Electrical (including related sub-sections)
 - 2. Section 270000 Communications
 - 3. Section 270526 Grounding and Bonding for Communications Systems
 - 4. Section 270528 Pathways for Communications
 - 5. Section 270810 Fiber Optic Testing and Measurements
 - 6. Section 271100 Communications Equipment Room Fittings
 - 7. Section 271300 Communications Backbone Cabling
 - 8. Section 274100 Audio-Visual Systems
 - 9. Section 280000 Electronic Security (including related sub-sections)

1.2 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts
 - 1. Refer to section 270000.
- D. Codes and Standards
 - 1. Refer to section 270000.

1.3 SUBMITTALS

- A. Refer to sections 270000 and 271300.

1.4 QUALITY ASSURANCE

- A. Refer to section 270000.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to sections 270000 and 271300.
- B. Storage temperature range: -40°F to 149°F (-40°C to 65°C)

1.6 PROJECT/SITE CONDITIONS

- A. Refer to section 270000.

1.7 WARRANTY

- A. Refer to section 270000.

1.8 MAINTENANCE AND SUPPORT

- A. Refer to section 271300.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Labeling
 - 1. Refer to section 270000.
- B. Firestopping
 - 1. Refer to section 270000.

2.2 ACCEPTABLE COPPER MANUFACTURERS

- A. Category 6 UTP Plenum Rated Cable
 - 1. Siemon – 9C6P4-E2-06-RXA
 - 2. Owner approved alternate
- B. ~~Data/Voice Outlet Components~~

1. ~~Siemon MX6-02 (White) MX6-20 (Ivory)~~
2. ~~Siemon 1 Port Faceplate MX-FP-S-01-02 (White) MX-FP-S-01-20 (Ivory)~~
3. ~~Siemon 2 Port Faceplate MX-FP-S-02-02 (White) MX-FP-S-02-20 (Ivory)~~
4. ~~Siemon 4 Port Faceplate MX-FP-S-04-02 (White) MX-FP-S-04-20 (Ivory)~~
5. ~~Siemon 6 Port Faceplate MX-FP-S-06-02 (White) MX-FP-S-06-20 (Ivory)~~
6. ~~Siemon 2 Port Surface Mount Box MX-SMZ2-02 (White) MX-SMZ2-20 (Ivory)~~
7. ~~Siemon Max Outlet Blanks MX-BL-02 (White) MX-BL-20 (Ivory)~~
8. ~~Owner approved alternate~~

C. Data/Voice Outlet Components

1. Siemon MX6-F02 (White)
2. Siemon MX6-F25 (Ivory)
3. Owner approved alternate

D. 1 Port Faceplate

1. Siemon – 1 Port Faceplate MX-FP-S-01-02 (White) MX-FP-S-01-20 (Ivory)
2. Owner approved alternate

E. 2 Port Faceplate

1. Siemon MX-FP-S-02-02 (White)
2. Siemon MX-FP-S-02-20 (Ivory)
3. Owner approved alternate

F. 4 Port Faceplate

1. Siemon MX-FP-S-04-02 (White)
2. Siemon MX-FP-S-04-20 (Ivory)
3. Owner approved alternate

G. 6 Port Faceplate

1. Siemon MX-FP-S-06-02 (White)
2. Siemon MX-FP-S-06-20 (Ivory)
3. Owner approved alternate

H. Outlet Blanks

1. Siemon MX-BL-02 (White)
2. Siemon MX-BL-20 (Ivory)
3. Owner approved alternate

I. Patch Panels (24 port)

1. Siemon – HD6-24
2. Owner approved alternate

J. Patch Panels (48 port)

1. Siemon – HD6-48
2. Owner approved alternate

K. Rack Blanks

1. Siemon – PNL-BLNK-2

L. Copper Patch Cords

1. Siemon
2. Owner approved alternate

2.3 ACCESSORIES

- A. Mount one laminated full-size hard copy in color of an as-built floor plan designating workstation locations, pathways, and communications room locations. Confirm hard copy size with Owner.
- B. Provide clear plastic lamination serving each communication room.
- C. Install the laminated drawings within a protective Plexiglas encasement on the wall of the servicing communications rooms. To ease accessibility the Plexiglas encasement shall be in either flip-down format or file folder format.

2.4 HORIZONTAL COPPER CABLING

- A. Recognized cabling for providing the signal medium from the work area to the communications room shall include the following:
 1. Category 6 UTP cable
 2. 75 Ohm coaxial cable.
- B. Category 6 UTP Cable Requirements
 1. 23/24 AWG solid bare copper
 2. Cable jacket shall comply with NEC Article 800 for use as a plenum cable and shall be UL and c (UL) Listed Type CMP (communications multipurpose plenum)
 3. Cable shall terminate on an eight-pin modular jack at each outlet. All horizontal cabling shall meet or exceed the ANSI/TIA-568-C.2 Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components
 4. Cables shall be marked as UL verified with a minimum of Category 6 rating
 5. The cable shall support Voice, Analog Base band Video/Audio, Fax, Modem, Switched-56, T-1, ISDN, RS-232, RS-422, RS-485, 10BASE-T Ethernet, Token Ring, 100Mbps TP-PMD, 100BASE-T Ethernet, 155 Mbps ATM, AES/EBU Digital Audio, 270 Mbps Digital Video, 622 Mbps 64-CAP ATM and emerging high-bandwidth applications, including 1 Gbps Ethernet, gigabit ATM, as well as all 77 channels (550 Mhz) of analog broadband video
 6. The maximum horizontal cable length for Category 6 copper cable from the termination of the cable in the communications room to the outlet is 295'-0".
 7. Cable shall meet or exceed the following electrical characteristics:
 8. Cable shall be specified to 250 MHz and shall meet the manufacturer's guaranteed electrical performance and physical specifications.

2.5 TERMINATION HARDWARE

- A. Patch panels
 - 1. Patch panels shall be rated to match installed cable plant
 - 2. The wiring block shall accommodate #23 AWG cable conductors.
 - 3. All modular cross connect panels shall be UL-listed.
- B. Work Area Outlet
 - 1. Universal eight-position jack pin/pair assignments
- C. Work Area Outlet Faceplates:
 - 1. White or ivory to match electrical outlets.

2.6 PATCH CABLES

- A. Verify exact quantities and lengths with Owner prior to purchase
- B. Patch Cable requirements:
 - 1. Category 6, stranded UTP cable
 - 2. Standard modular non-keyed, 8-position 8-conductor plug
 - 3. 94V-0 rated
 - 4. UL listed
 - 5. Meets FCC Part 68
- C. Provide 3'-0", 5'-0", 7'-0", and 10'-0" Patch Cords at the communications room for each installed port.
 - 1. Coordinate with Owner on the active equipment layout prior to purchase to ensure correct sizing of patch cords from patch panels to switching equipment.
- D. Provide a 10'-0" Station Cord for each work area outlet port.
- E. All cords shall conform to the requirements of ANSI/TIA-568-C.2 Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL LAN Certification and Follow-up Program.
- F. Cords shall be equipped with an eight-pin modular connector on each end, wired straight through and shall be of appropriate length for application.
- G. All rated patch cords shall be round, and consist of #23 AWG copper, stranded conductors, tightly twisted into individual pairs.
- H. Patch cords shall be made and warranted by the manufacturer of the cabling system installed in this project and shall meet or exceed patch cord specifications as outlined in TIA standards.

2.7 IDENTIFICATION (LABELING) SYSTEM

- A. Refer to sections 270000 and 271300.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to Section 270000 and 271300.

3.2 PREPARATION

- A. Refer to section 270000.
- B. The Contractor shall check pathways, raceways, and other elements for compliance with space allocations, installation tolerances, debris, hazards to cable installation, and other conditions affecting installation prior to installation.

3.3 INSTALLATION REQUIREMENTS

- A. Refer to section 270000.
- B. All installation shall be done in conformance with ANSI/TIA-568-C standards, BICSI methods, industry standards and manufacturer's installation guidelines.
 - 1. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
 - 2. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.
 - 3. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- C. Install cable using techniques, practices, and methods that are consistent with specified data cabling and the installed components and that ensure specified performance levels of completed and linked signal paths, end to end.
 - 1. Pull cables in smooth and regular motions using methods that prevent cable kinking.
 - 2. Pull cables simultaneously if more than one is being installed in the same raceway/pathway.
 - 3. If necessary, use approved cable pulling lubricant
 - 4. Use fish tape, cable, rope, basket weave wire/cable grips, and other tools that will ensure no damage to the media or raceway.
 - 5. Install open cabling parallel and perpendicular to surfaces or structural members following surface contours where possible.
 - 6. Do not bend cable greater than a bend radius of 0'-1".
- D. Provide a 10'-0" service loop at the communications room and shall provide a 3'-0" service loop above the access ceiling or cable trays unless specified otherwise.
 - 1. All service loops shall be a minimum of 1'-6" (18") in diameter and be accessible for maintenance.
- E. Coordinate loop placement and orientation with the technology consultant.

1. This allows for future changes or expansion without installing new cables.
- F. Install cables in continuous “home run” lengths from work station outlet to specified patch panel.
 1. No intermediate punch down blocks or splices may be installed or utilized between the communications rooms and the workstation outlet without written Owner permission.
- G. All cable must be handled with care during installation so as not to change performance specifications.
 1. Factory twists of each individual pair must be maintained up to the connection points at both ends of the cable.
 2. There shall never be more than 0'-½" of unsheathed cable at either the wiring closet or the workstation termination locations.
- H. All cabling and associated hardware shall be placed so as to make efficient use of available space.
 1. All cabling and associated hardware shall be placed so as not to impair equipment's efficient use of their full capacity.

3.4 CABLING METHODS

- A. The Contractor shall provide cabling in accessible spaces, cable tray, (surface and/or enclosed raceway), conduits, and/or J-Hook cable support system.
 1. Within consoles, racks, cabinets, desks, and counters, in accessible ceilings spaces and in gypsum board partitions where open cable method may be used.
 2. Use UL or ETL listed plenum rated cable in all spaces.
 3. Provide all necessary installation materials, hardware, tools and equipment to perform insulation displacement type terminations at all data outlets and patch panel materials.
- B. Conceal raceway and cabling except in unfinished spaces as is practical.
- C. Exposed Cable
 1. All station cabling shall be installed inside walls or ceiling spaces whenever possible.
 2. Exposed station cable will only be run where indicated on the drawings and will only be allowed when no other options exist.
 - a) Owner must approve all exceptions.
- D. The Contractor shall utilize conduits/cable tray as indicated on the drawings.
- E. All cabling placed above drop ceilings must be supported by cable tray, J-hooks, caddy bags or conduit.
 1. The Contractor shall permanently affix cable supports to the building structure or substrates and provide attachment hardware and anchors designed for the structure to which attached and are suitably sized to sustain the weight of the cables to be supported.
 - a) Attaching cable to pipes or other mechanical items is not permitted.
 - b) Cabling shall not be attached to ceiling grid wires.

2. Multiple cables are to be dressed every 5'-0" to 7'-0".
 - a) Maximum cable sag between cable hooks is 3"-6".
 - F. The Contractor shall route data and voice cables separately in a neat and orderly fashion.
 1. No cable ties or wraps shall be used to secure the cables in the runway outside of the communications rooms. Cable ties shall be rated for the environment.
 - G. Keep all items protected before and after installation with dust and moisture proof barrier materials/envelopes.
 - H. If wiring is terminated on patch panels, data, voice jacks prior to painting, carpet installation, and general finish clean up, these jacks shall be placed in a protective envelope to ensure dust, debris, moisture, and other foreign material do not settle onto jacks' contacts.
 1. Envelope will be removed on final trim out after other trades have completed their finish work.
 2. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.
 - a) Cable bundles brought into the communications rooms shall be routed and dressed in such a manner that prior to termination the cables are not subject to damage and misuse such as installers walking on the bundles that are on the floor.
 - b) Cable pulling force shall not exceed 25 lbs of pulling tension or cable manufacturer's recommended pulling tensions.
 - c) Do not leave cables on the floor unprotected or cable bundles hanging from the ceilings. Coil them up in a temporary manner and protect them from damage.
 - I. Communications room cables shall be combed and dressed in a manner as to prevent twists, "braiding" and crossed cables in the cable bundle from the communication room entrance to the termination point at the rear of the patch panel.
 1. Behind the patch panel, the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.
 - a) Use Velcro wraps instead of cables ties for all bundling in the communications rooms.
 - b) Plastic/nylon tie-wraps are not allowed to permanently secure cables inside the communications room.
- 3.5 CABLING SEPARATION
- A. Comply with TIA rules for separating unshielded copper communication and data-processing equipment cables from potential EMI sources, including electrical power lines and equipment.
 - B. Maintain a minimum spacing of 1'-6" (18") from electrical feeders and/or branch circuit wiring including, but not limited to, light fixtures, sources of heat and EMI sources.
 - C. Maintain a minimum spacing of 1'-0" from auxiliary systems cabling.

- D. Maintain a 1'-0" separation where cables must pass perpendicularly to electrical, plumbing, or other wiring, conduit, or piping systems.
 - 1. Use non-conduit bushings, if necessary to maintain separation, which allow for the addition of a reasonable number of cables in the future.
- E. Maintain communications pathways away from electrical apparatus such as motor driven equipment and transformers, minimum separation distance of 10'-0" is recommended.

3.6 CABLING TERMINATION

- A. Terminate cables in consistent consecutive order.
- B. Terminate cables onto 8P8C modular patch panels without damaging twisted pairs or jacket.
- C. Arrange cables on patch panels in ascending order of room numbers and outlet numbers within rooms.
- D. Provide a 10'-0" service loop for horizontal cables at each rack in communications rooms.
 - 1. Locate loop at ceiling deck or on bottom of cable runway in minimum 1'-6" (18") diameter.
- E. Provide a 3'-6" service loop for horizontal cables at work area outlets. Locate service loop above or below data/voice outlet where vertical cable run transitions to horizontal run.
- F. Maintain twists in cable pairs to within 0'-½" of termination.
- G. Video Surveillance Systems Cabling (Electronic Safety and Security <ESS> devices)
 - 1. Video Cameras will require a field terminated plug on the end of a horizontal cable to be directly plugged into device.
 - a) Follow TIA-862-A Building Automation Standard.
 - b) Contractor shall use applicable equipment in testing solid conductor plug.
 - 2. Group all security systems cables in one group.
 - 3. Clearly label cable number and function, in the last positions on the horizontal cabling blocks in each communications room.
- H. Building Systems Cabling (BAS, FA, elevator line, etc)
 - 1. Coordinate exact placement and connectivity requirements with applicable trade prior to installation.
 - 2. Group all building systems cables in one group.
 - 3. Clearly label cable number and function, in the last positions on the horizontal cabling blocks in each communications room.
- I. Limit cable-bending radius to 20X the cable diameter during installation, and 15X the cable diameter after installation.
- J. Start numbering at the left of the main door to the room and continue in a clockwise direction around the room.

1. The cables within the room will be terminated starting with the cables located to the left of the main door to the room and continue around the room in a clockwise direction.

3.7 TERMINATION HARDWARE

A. Station Hardware

1. Flush mount jacks shall be mounted in a faceplate with back box.
2. Outlets shall not be mounted on temporary, movable, or removable surfaces, doors, or access hatches without prior Owner approval.
3. 8P8C Jack Pin Assignments for work area outlets shall match the T-568B wiring scheme.

B. Patch panels

1. Copper cables shall be terminated in eight position/eight conductor (8P8C) modular patch panels.
2. All Modular jack panels shall match the T-568B wiring scheme.

C. Work Area Outlet

1. 8P8C non-keyed modular outlets for applications up to one Gbps and ANSI/TIA-568-C compliant for the specified transmission requirements

D. Work Area Outlet Faceplates:

1. Furnish and install blank plates in all unused ports.

3.8 SPECIAL CIRCUITS

- #### A.
- The Contractor shall coordinate with the Owner on the cable termination plan for special circuits, including cables to wireless access point locations, security, elevators, fire alarms, etc.

B. Wireless Access Points

1. Install two (2) cable(s) from dedicated wireless patch panel(s) in communications room to outlets having 8P8C connectors within a secure metal enclosure.
2. Enclosures shall be NEMA rated for the environment to which they are exposed.
3. 30'-0" of cable slack shall be coiled and hung on a "J"-hook at the enclosure location.

3.9 IDENTIFICATION AND LABELING

- #### A.
- Labeling system shall consist of a hand-held portable printer and labels appropriate to the application. Handwritten labels are not acceptable.
- #### B.
- Fiber termination hardware (designation strip) shall have a 0'- $\frac{3}{4}$ " x 0'- $\frac{1}{4}$ " thermal transfer printable label with a permanent acrylic adhesive
- #### C.
- All labels shall be permanent and shall not fade, peel, or deteriorate due to environment or time.
- #### D.
- The Contractor shall provide a copy of the finalized plan in writing to the Owner representative and DataCom Design Group for review and authorization to proceed.

1. Coordinate with Owner for specifications on labeling of all hardware, cabling, and related equipment prior to any testing.

E. Labeling requirements:

1. Label cable terminations on designation strips
2. Label all cable at each terminating point.
3. Label each port of the work area outlet.
4. Cable identification numbers shall not be duplicated.
5. Label patch panels in the communications rooms to match those on the corresponding voice and data outlets.
 - a) The font shall be at least 0'-1/8" in height.
6. Where a wireless access point is installed above an acoustical ceiling, label the ceiling grid frame below the access point, displaying the data port number and, if applicable, the access point identification number. Coordinate labeling of grid with Owner and Architect prior to application of labels.
7. Label each distribution rack, block and other terminating equipment unit and field within that unit within 0'-4" from the block or patch panel termination. Keep labels in a neat and orderly lineup.
8. Label each connector and each discrete unit of cable-terminating and connecting hardware within connector fields, in wiring closets and equipment rooms.
 - a) Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.
9. Post the cable schedule in a prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations.

F. Location and termination field description

1. Room location
2. Rack-mount or Wall mount
3. Termination field type
 - a) Specific patch panel ports versus a separate dedicated patch panel

G. Unique identifiers

1. Segregation and position on equipment rack
2. Port color-coding
3. Unique labeling

H. Documentation

1. Provide electronic copy of final comprehensive schedules for project in software and format selected by Owner.
 - a) All labels shall correspond to as-built drawings and to final test reports.
2. All cable inventory data documentation shall be submitted in format coordinated with and approved by Owner so that data can be incorporated into existing databases.

3. Documentation shall include cable identification number, source and destination, type of cable, length of cable and number of pairs or fibers.
4. Complete cross connect documentation is required.

3.10 FIELD QUALITY CONTROL

- A. Refer to section 270000.

3.11 POST-INSTALLATION TESTING

- A. Contractor shall test each pair or strand of every cable prior to acceptance. (100% PASS)
- B. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.
- C. Standards Compliance and Test Requirements:
 1. Cabling shall meet ANSI/TIA-568-C.2 Category 6 Horizontal cabling requirements.
- D. Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin.
 1. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements.
 2. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.
 3. Length, propagation delay, and delay skew relative to the relevant limit.
 - a) Length, propagation delay, and delay skew shall be tested relative to the relevant limit.
 - b) Test shall also include mutual capacitance and characteristic impedance.
 - 1) Any individual test that fails the relevant performance specification shall be marked as a 'FAIL'.
- E. Cable Test Documentation:
 1. Cable test documentation shall be submitted in hard copy and electronic formats.
 - a) If proprietary software is used, disk or CD shall contain any necessary software application required to view test results.
 - b) Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report.
 - c) Certificate shall reference traceable circuit numbers that match the electronic record.
 2. Each test record shall contain the cable ID as follows:
 - a) "MEDIA TYPE – SOURCE ROOM – DESTINATION ROOM – STRAND/PAIR #",
e.g. MM-MC-HC23-001.

3. Test results saved within the field-test instrument shall be transferred into an accessible database utility that allows for the maintenance, inspection and archiving of the test records.
 - a) These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument".
 - b) The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
4. Test reports shall include the following information for each cabling element:
 - a) Wire map results that indicate that 100% of the cabling has been tested for shorts, opens, miss-wires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.
 - b) Length, propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.
 - c) Cable manufacturer, cable model number/type, and NVP
 - d) Tester make & model, serial number, hardware version, and software version.
 - e) Cable ID and project name
 - f) Auto-test specification used
 - g) Overall pass/fail indication
 - h) Date of test

F. Cable Test Equipment

1. Contractor shall supply all of the required test equipment used to conduct acceptance tests.
2. Test equipment used under this contract shall be from manufacturers that have a minimum of 5 years experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
3. Testing equipment shall be UL-verified to meet Level III accuracy.
 - a) The cable installers shall have a copy of this reference in their possession and be familiar with the contents.
4. Testing equipment shall be within the calibration period recommended by the manufacturer.
5. Testing equipment shall have the latest software and firmware installed.
6. Testing equipment of a given type shall be from the same manufacturer, and have compatible electronic results output.
7. Test adapter cables shall be approved by the manufacturer of the test equipment.
 - a) Adapter cables from other sources are not acceptable.
 - b) Adapter cables must be replaced after 1000 tests to ensure accuracy.
8. Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.
9. Test equipment must be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
10. Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
11. Test equipment must be capable of running individual NEXT, return loss, etc measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
12. Test equipment must include a library of cable types, sorted by major manufacturer.

13. Test equipment must be able to internally group auto tests and cables in project folders for good records management.
 - a) Test equipment must store at least 1000 auto tests in internal memory.
14. Test equipment must include DSP technology for support of advanced measurements.
15. Test equipment must make swept frequency measurements in compliance with TIA standards.
16. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector.
17. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
18. Acceptable testers:
 - a) Fluke DTX CableAnalyzer
 - b) Owner approved equivalent

3.12 FIBER TESTING

- A. Refer to Section 271300.

3.13 CLEANING

- A. Refer to section 270000.

3.14 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.
- B. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein.
- C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and submittal and approval of full documentation as described above. Tests with the "** PASS" (asterisk) will not be acceptable.
 1. These circuits must be repaired to meet "PASS".

END OF SECTION

SECTION 27 41 13

ARCHITECTURALLY INTEGRATED AUDIOVISUAL INFRASTRUCTURE

PART 1 GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 01 – General Requirements apply.

1.2 SECTION INCLUDES

- A. Floor Boxes
- B. Poke-Thru Devices
- C. Flat Panel Display In-Wall Storage Boxes
- D. Wall Junction Boxes
- E. Pull Boxes
- F. Plenum Ceiling Boxes
- G. Projection Screens

1.3 RELATED SECTIONS

- A. Division 09 – Flooring Systems
- B. Division 26 – Electrical: Electrical Systems and Components
- C. Division 27 – Communications: Communications Systems and Components
- D. Division 28 – Electronic Safety and Security: Security Systems and Components

1.4 Submittals

- A. Comply with requirements of Section 01 33 00 – Submittal Procedures.
 - 1. Product Data: For the following AV Infrastructure System components:
 - a. Floor Boxes
 - b. Poke-Thru Devices
 - c. Flat Panel Display In-Wall Storage Boxes
 - d. Wall Junction Boxes
 - e. Pull Boxes
 - f. Plenum Ceiling Boxes
 - g. Projection Screens
 - 2. Shop Drawings: For the following AV Infrastructure System components. Include plans, elevations, sections, details, and attachments to other work:
 - a. Floor Boxes
 - b. Poke-Thru Devices
 - c. Flat Panel Display In-Wall Storage Boxes
 - d. Wall Junction Boxes
 - e. Pull Boxes
 - f. Plenum Ceiling Boxes
 - g. Projection Screens

1.5 QUALITY ASSURANCE

A. General:

1. Floor Boxes provide the interface between power, audio-video (A/V), and communications cabling in concrete floors and decks at activation locations requiring power, audio-video, or communication device outlets.
 - a. ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.
2. Poke-thru devices provide the interface between power, communication and audio-video (A/V) cabling in an above grade concrete floor and the activation location where power communication and/or A/V device outlets are required. These poke-thru devices provide recessed device outlets that will not obstruct the floor area.
 - a. ADA Compliance: Flush-mounted floor device outlets shall not create tripping hazard.
3. Flat Panel Display In-Wall Storage Boxes provide the interface between power, audio-video (A/V), and communications cabling in recessed cavity of wall behind flat panel displays where power, communication and/or A/V device outlets and/or device storage/mounting is required.
4. Wall Outlet Boxes provide the interface between power, audio-video (A/V) and communications cabling in walls at activation locations requiring power, audio-video, or communication device outlets.
5. Pull and Junction boxes provide an accessible pathway in a run of conduit to facilitate the pulling in of wires and cables.

B. Manufacturer Qualifications: Firms regularly engaged in manufacture of floor boxes, poke-thru devices and in-wall storage boxes of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide floor boxes, poke-thru devices, in-wall storage boxes, electrical junction boxes, pull boxes and plenum ceiling boxes that are produced by a manufacturer listed in this section.

C. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to raceways and components. Listed and labeled in accordance with NFPA 70, Article 100.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver floor boxes, poke-thru devices, and in-wall storage boxes and associated fittings in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 PRODUCTS

2.1 GUIDELINES

- A. Floor Boxes, Poke-thru Devices, Wall Junction Boxes and Pull & Junction Boxes shall be furnished and installed by the Electrical Contractor selected by the Owner unless specifically excluded in these specifications or drawings.

1. Coordinate with AV Contractor regarding proper placement of duplex outlets for any AV designated floor box or Poke-thru Device. Electrical circuits should be connected (and outlets wired) to the designated AV circuit breaker panel (N.I.C.). Ensure that "Star" ground configuration is properly implemented. Ensure that ground wires from each outlet are isolated from conduit, neutrals, and each other.
- B. In-Wall Storage Boxes and Plenum Ceiling Boxes shall be furnished, and installed by the Electrical Contractor unless specifically excluded in these specifications or drawings.
1. Coordinate with AV Contractor regarding proper placement of duplex outlets for any AV designated Plenum Ceiling Box and/or In-Wall Storage Box.
- C. Floor Box Inserts/Plate and Poke-thru Device Inserts/Plates shall be furnished and installed by the AV Contractor selected by the Owner unless specifically excluded in these specifications or drawings.
- D. Condition - Provide and install products listed in this section in factory new condition, conforming to applicable provisions of American National Standards Institute.

2.2 ACCEPTABLE MANUFACTURER

A. Basis of Design Product:

1. The design for floor boxes and fittings is based on the FL Floor Box Series manufactured by FSR, Inc., 244 Bergen Blvd., Woodland Park. NJ 07424, telephone 973- 998-2000, Web Site: www.fsrinc.com).
2. The design for poke-thru devices and fittings is based on the Evolution Poke-thru Device Series manufactured by Legrand/Wiremold , 60 Woodlawn Street, West Hartford, CT 06110; toll-free 800-621-0049, telephone 860-233-6251, fax 860-232-2062; Web Site: www.legrand.us/Wiremold.com. (OR: *poke-thru devices and fittings manufactured by FSR, Inc., 244 Bergen Blvd., Woodland Park. NJ 07424, telephone 973- 998-2000, Web Site: www.fsrinc.com).*
3. The design for in-wall storage boxes and fittings is based on the PAC52* Series In-Wall Storage Box Series manufactured by Chief Manufacturing, 6436 City West Parkway, Eden Prairie, MN 55344, toll-free 800-582-6480, telephone 952-894-6280, fax 877-894-6918, Web Site: www.chiefmfg.com.
4. The design for wall junction boxes and fittings is based on products manufactured by RACO, 3902 West Sample Street, South Bend IN 46634-4002, telephone 800-722-6437, Web Site: www.hubbell-rtb.com. (OR: *Garvin Industries, 3700 Sandra Street, Franklin Park, IL, telephone 847-455-0188, fax 847-455-0334; Web Site: www.garvinindustries.com*).
5. The design for pull boxes and fittings is based on products manufactured by Hoffman, a Pentair Company, 2100 Hoffman Way, Anoka, MN, telephone 763-421-2241, fax 763-422-2600; Web Site: www.hoffmanonline.com.
6. The design for plenum ceiling boxes and fittings is based on the CB Plenum Rated Storage Box series manufactured by FSR, Inc., 244 Bergen Blvd., Woodland Park. NJ 07424, telephone 973- 998-2000, Web Site: www.fsrinc.com.

7. The design for projection screens is based on products manufactured by Draper, Inc., 411 South Pearl Street. Spiceland, IN 47385, toll free 800-238-7999, telephone 765-987-7999, fax 765-987-7142, Web Site: www.draperinc.com. (OR: Da-Lite, 3100 N. Detroit Street, Warsaw, IN 46582, toll-free 800-622-3737, Web Site: www.da-lite.com). (OR: Stewart Filmscreen, 1161 W. Sepulveda Blvd, Torrance, CA 90502-2754, toll-free 800-762-4999, Web Site: www.stewartfilmscreen.com).

B. Substitutions will be considered under provisions of Section 01 25 00.

2.3 FLOOR BOXES

- A. Classification and Use: Floor boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and/or UL514C and Canadian Standard C22.2, No. 18.1-04 and 18.2-06 and bear the U.S. and Canadian UL Listing Mark. Floor boxes shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Devices shall be classified for use in 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the floor boxes). Floor boxes shall also conform to the standards set in Section 300-21 of the National Electrical Code. Floor boxes shall meet UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. Floor boxes shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, bare concrete, terrazzo, wood, and carpet covered floors. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22 (C) of the National Electrical Code.

B. Floor Boxes, General: FSR FL 500 Series Floor Boxes for use on on-grade and above grade concrete floors, raised floors or wood floors. Provide boxes with a component to permit installation in polished concrete or terrazzo floors. Boxes shall be compatible with complete line of Ortronics® workstation connectivity outlets and modular inserts.

1. Floor boxes provide the interface between power, communication and audio/video (A/V) cabling in above-grade floors, on-grade concrete floors, raised floors, wood floors, and fire-classified floors and the workstation or activation location where power and communication and/or A/V device outlets are required. Boxes shall provide recessed device outlets that will not obstruct the floor area. Refer to Drawings for size and types.
2. When installed in on-grade slab with dirt in-fill, provide with the pour pan accessory.
3. When installing in elevated concrete slabs on upper floors, Contractor must provide a fire-rated assembly of 2 hours. Contractor must follow manufacturer's installation instructions to insure a 2-hour assembly.
4. Floor boxes shall permit all wiring to be completed at floor level. The FC models shall be used as defined by the UL Fire Resistance Directory at a minimum spacing of two (2) ft. [610mm] on center.

C. (FB TYPE 1) FL-500-6-P Floor Boxes: Manufactured from stamped steel with optional pour pan approved for use on-grade concrete floors. Boxes shall have the ability to accept a component that will allow the box to be installed in polished concrete or terrazzo floors. Provide boxes with three (3) independent wiring compartments configured in the 1-2 scenario. That allow for up to two (2) receptacles, communication and/or audio/video services. Boxes shall have removable and relocatable dividers to permit custom configuration of compartments as well as permit feed to adjacent

compartments. Boxes shall permit feed to compartments on the opposite side of the box through a tunnel. Each of the three (3) compartments shall have a minimum depth of 3-7/8" [98mm] behind the plate. Provide boxes with removable compartments to facilitate installation and moves, additions, and changes. The compartments shall be removable from the top and back of the floor box. Provide boxes with two (2) cable guides to organize and maintain the cables egress out of the box. Provide boxes with removable knockout plates to allow for the maximum cable pass-through area. The cable pass-through area shall be a minimum of 6-15/16 in² [176mm²]. Boxes shall be fully adjustable, accommodating a maximum 2-inch [51mm] pre-concrete pour and a maximum 1/2" [12.7mm] post-concrete pour adjustment. The box shall be able to accept 2-3/4" x 4-1/2" standard size wall plates. Include mounting brackets with the boxes that will accommodate two (2) 20 amp straight blade, receptacles, Ortronics® workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers.

- D. (FB TYPE 2) FL-500P-6-FRK Floor Boxes: Manufactured from stamped steel approved for use above-grade concrete floors. Floor Box assembly to have a 2-hour fire rating. Boxes shall have the ability to accept a component that will allow the box to be installed in polished concrete or terrazzo floors. Provide boxes with three (3) independent wiring compartments that allow for up to two (2) receptacles, communication and/or audio/video services. Boxes shall have removable and relocatable dividers to permit custom configuration of compartments as well as permit feed to adjacent compartments. Boxes shall permit feed to compartments on the opposite side of the box through a tunnel. Each of the three (3) compartments shall have a minimum depth of 3-7/8" [98mm] behind the plate. Provide boxes with removable compartments to facilitate installation and moves, additions, and changes. The compartments shall be removable from the top and back of the floor box. Provide boxes with two (2) cable guides to organize and maintain the cables egress out of the box. Provide boxes with removable knockout plates to allow for the maximum cable pass-through area. The cable pass-through area shall be a minimum of 6-15/16 in² [176mm²]. Boxes shall be fully adjustable, accommodating a maximum 2-inch [51mm] pre-concrete pour and a maximum 1/2" [12.7mm] post-concrete pour adjustment. The box shall be able to accept 2-3/4" x 4-1/2" standard size wall plates. Include mounting brackets with the boxes that will accommodate two (2) 20 amp straight blade, receptacles, Ortronics® workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers.

2.4 FLOOR BOX COVERS

- A. FSR FL Series Covers: Manufactured of stamped steel. Covers shall be available in surface mount and flush versions. Covers to be UL scrub water rated. Covers shall be available with a carpet recess area or a solid lid. Coordinate cover type with floor finish. Coordinate cover selection and color with Architect.

2.5 FLOOR BOX COMMUNICATION MODULES MOUNTING ACCESSORIES

2.6 POKE-THRU DEVICES

- A. Manufacturer – The Evolution Poke-Thru Devices described shall be manufactured by Wiremold/Legrand. The poke-thru device shall be compatible with the complete line of Ortronics® workstation connectivity outlets and modular inserts, or the Pass & Seymour Network Wiring System. Poke-thru devices of other manufacturers may be considered, if equal in functionality and quality, by written approval of the specifying engineer and shall meet all the performance standards specified herein. The same manufacturer shall provide all poke-thru types for the project. In addition, the contractor shall have ten days prior to the date for receipt of bids to submit to the specifying engineer a working sample from any other manufacturer.

- B. (PT TYPE 1) 6AT Poke-Thru Assembly – This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 16 3/4" [425mm].

1. Insert:

- a. The insert body shall recess the devices a minimum of 2 3/4" [69 mm] and have a polyester based backing enamel finished interior (ivory). There shall be the necessary channels to provide complete separation of power and communication services. There shall be three compartments that allow for up to three duplex receptacles that can be wired as a standard receptacle or isolated ground and/or twelve communication ports and/or ten of Extron® Electronics MAAP™ and/or two AAP™ devices.
- b. The body will consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have retaining feature that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4" trade size conduit stub that is connected to the insert body and a 24.5 cu. in. [402ml] stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground.

2. Activation Cover – The activation covers shall be manufactured of die-cast aluminum alloy and be available in powder-coated gray, black, or plated in brass, nickel or bronze finish. Two gaskets (one for carpet and one for tile) are provided to go under the trim flange to maintain scrub water tightness. The activation cover shall be 7 1/4" [184mm] in diameter. The activation covers shall be available in carpet and tile versions. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.

3. Communication Modules Mounting Accessories – The activation shall have three locations to mount communication connectors. Connectors shall be mounted using a mounting bracket. Mounting brackets shall be provided to mount up to twelve Ortronics TracJack Category 6 insert modules or TechChoice™ Category 6 discrete keystone connectors. The unit will also be supplied with two Category 6 keystone connectors and two Lucent® keystones. The unit shall also accommodate a mechanism to permit protection of communication cabling. This mechanism shall be stamped steel construction and accept both flexible and rigid conduit. This mechanism shall accept 3/4", 1-1/4" or 2" trade size conduits.

- C. (PT TYPE 2) 8AT Poke-Thru Assembly – This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 16 3/4" [425mm].

1. Insert:

- a. The insert body shall recess the devices a minimum of 2 3/4" [69 mm] and have a polyester based backing enamel finished interior (ivory). There shall be the necessary channels to provide complete separation of power and communication services. There shall be five compartments that allow for up to five duplex receptacles that can be wired as a standard receptacle or isolated ground and/or twenty-two communication ports and/or sixteen of Extron® Electronics MAAP™ and/or four AAP™ devices.
- b. The body will consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire rating of the unit and the floor slab. The insert shall have

retaining feature that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 3/4" trade size conduit stub that is connected to the insert body and a 24.5 cu. in. [402ml] stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru device to the system ground.

2. Activation Cover – The activation covers shall be manufactured of die-cast aluminum alloy and be available in powder-coated gray, black, or plated in brass, nickel or bronze finish. Two gaskets (one for carpet and one for tile) are provided to go under of the trim flange to maintain scrub water tightness. The activation cover shall be 9 1/4" [235mm] in diameter. The activation covers shall be available in carpet and tile versions. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The cover shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.
3. Communication Modules Mounting Accessories – The activation shall have three locations to mount communication connectors. Connectors shall be mounted using a mounting bracket. Mounting brackets shall be provided to mount up to twelve Ortronics TracJack Category 6 insert modules or TechChoice™ Category 6 discrete keystone connectors. The unit will also be supplied with two Category 6 keystone connectors and two Lucent® keystones. The unit shall also accommodate a mechanism to permit protection of communication cabling. This mechanism shall be stamped steel construction and accept both flexible and rigid conduit. This mechanism shall accept 3/4", 1-1/4" or 2" trade size conduits.

2.7 FLAT PANEL DISPLAY IN-WALL STORAGE BOX

- A. Classification and Use: In-Wall Storage Boxes shall have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. UL Classification Mark. In-wall storage boxes shall be suitable for use in air handling spaces in accordance with Section 300-22 (C) of the National Electrical Code.
- B. (FPD TYPE 1) Model PAC525FCW In-Wall Storage Box with Flange and Cover: Manufactured from stamped steel approved for use in standard 3.5" stud and 2.5" stud walls with the same product. Box shall have a finished interior, black in color. Boxes shall be 9" H x 14.25" W x 3.9" D [228.6mm x 361.95mm x 99.06mm]. Knockouts shall be provided for single gang outlets and 1-1/4" & 1/2" conduit. Box shall have universal zip tie anchor points. Box shall be provided with a paintable flange and cover. Cover shall include tamper proof security and include four knockouts for cable routing and ventilation.
 1. Provide with Raco 560 3" x 2" box, 2-3/4" deep electrical box.
 2. Provide with Raco 864 single duplex electrical box cover.
- C. (FPD TYPE 2) Model PAC526FCW Large In-Wall Storage Box with Flange and Cover: Manufactured from stamped steel approved for use in standard 3.5" stud and 2.5" stud walls with the same product. Box shall have a finished interior, black in color. Boxes shall be 14.25" H x 14.25" W x 3.9" D [361.95mm x 361.95mm x 99.06mm]. Knockouts shall be provided for single gang outlets and 1-1/4" & 1/2" conduit. Box shall have universal zip tie anchor points. Box shall be provided with a paintable flange and cover. Cover shall include tamper proof security and include four knockouts for cable routing and ventilation.
 1. Provide with Raco 560 3" x 2" box, 2-3/4" deep electrical box.
 2. Provide with Raco 864 single duplex electrical box cover.

2.8 WALL JUNCTION BOXES

- A. All device boxes for communications systems shall be extra-deep designation.
- B. Sheet Metal Junction Boxes: NEMA OS 1, UL 514A, galvanized steel with stamped knockouts.
- C. Wall mounted communication boxes concealed within the wall shall be a minimum 4-11/16" square with a minimum depth of 3" with reducer device plate per schedule.
- D. Antenna Junction Box (A) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.
- E. AV Plate Junction Box (AVP TYPE 1) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.
- F. AV Plate Junction Box (AVP TYPE 2) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 818 two gang device cover.
- G. AV Plate Junction Box (AVP TYPE 3) Raco Model 263 Electrical Junction Boxes shall be 3-1/2" Deep, 6" Square with (6) 1/2"-3/4", (2) 3/4"-1" and (2) 1"-1-1/4" side knockouts and (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" bottom knockouts. Box shall be provided with Raco 793 three gang device cover.
- H. Camera Junction Box (CAM) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 818 two gang device cover.
- I. Intercom Call Button (CB) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.
- J. Listening Assist Transmitter Junction Box (LA) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 818 two gang device cover.
- K. Projector (PRJ) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 818 two gang device cover.
- L. Paging Speaker (PS) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.
- M. Sound Reinforcement Speaker Junction Box (S) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.
- N. Switch Junction Box (SWT) Raco Model 471 Electrical Junction Boxes shall be 2-1/4" deep, 3" x 2" with one 1/2" conduit knockout.
- O. Volume Control Junction Box (VC) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.

- P. Wall Control Panel Junction Box (WCP TYPE 1) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 843 single gang device cover.
- Q. Wall Control Panel Junction Box (WCP TYPE 2) Raco Model 260 Electrical Junction Boxes shall be 3-1/4" deep, 4-11/16" square with (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" side knockouts and (2) 1/2" & (2) 3/4"-1" bottom knockouts. Box shall be provided with Raco 818 two gang device cover.
- R. Wall Control Panel Junction Box (WCP TYPE 3) Raco Model 263 Electrical Junction Boxes shall be 3-1/2" Deep, 6" Square with (6) 1/2"-3/4", (2) 3/4"-1" and (2) 1"-1-1/4" side knockouts and (2) 1/2"-3/4", (2) 3/4"-1" and (2) 1-1/4" bottom knockouts. Box shall be provided with Raco 793 three gang device cover.
- S. Specific-use Wall Junction Boxes:
 - 1. For situations where oversized conduit is used so a standard 4-11/16"x4-11/16" box is inadequate for the terminations required, use:
 - a. Hubbell Recessed Wall Mounted Gang – WSCS-MMO-X per schedule, or approved equal.

2.9 PULL BOXES

- A. Small Sheet Metal Pull Boxes: NEMA OS1; galvanized steel
- B. Minimum size:
 - 1. 4" square by 2.125" deep for use with 1" conduit and smaller
 - 2. 4-11/16" square by 3" deep for use with 1-1/4" conduit and larger.
- C. Maximum size:
 - 1. 24" square by 8" deep for collecting multiple 1" station conduit. Sheet metal boxes larger than 12" in any direction are required to have a hinged cover or a chain installed between box and cover.
- D. Manufacturers: Hoffman Enclosures or approved equal. Field fabricated boxes are not allowed.
- E. Floor Mounted Rack Pull Box (FRK) Hoffman Item #ASE16X14X4NK 16" x 14" x 4" deep square pull box. Box shall be provided with screw cover.
- F. Millwork Mounted Rack Pull Box (MRK) HOFFMAN ASE8x9x3 8" x 9" x 3" NEMA 1 pull box. Box shall be provided with screw cover.
- G. Wall Mounted Rack Pull Box (WRK) Hoffman Model ASE16X14X3 16" x 14" x 3" screw cover pull box at wall behind rack.
- H. Paging Speaker Pull Box (PS) – Hoffman Model ASE4X4X3 4" x 4" x 3".
- I. Sound Reinforcement Loudspeaker (S) – Hoffman Model ASE4X4X3 4" x 4" x 3"

2.10 PLENUM CEILING BOXES

- A. Projector Mount Plenum Ceiling Box (PRJ TYPE 1) FSR, Inc. Model CB-12P 1' x 2' plenum

rated ceiling box with projector pole adapter.

1. Provide with CB-THRD threaded rod mounting kit.
- B. Projector Mount Plenum Ceiling Box (PRJ TYPE 2) FSR, Inc. Model CB-22P 2' x 2' plenum rated ceiling box with projector pole adapter.
 1. Provide with CB-THRD threaded rod mounting kit.
- C. Storage Ceiling Plenum Box (SCB TYPE 1) FSR, Inc. Model CB-12 1' x 2' plenum rated ceiling enclosure.
 1. Provide with CB-THRD threaded rod mounting kit.
- D. Storage Ceiling Plenum Box (SCB TYPE 2) FSR, Inc. Model CB-22 2' x 2' plenum rated ceiling enclosure.
 1. Provide with CB-THRD threaded rod mounting kit.

2.11 MOTORIZED, CEILING RECESSED, FRONT PROJECTION SCREENS

- A. Access//Series V: Electric motor operated, steel case. Ceiling-recessed, 18-gauge steel headbox, 6-1/2 inches (182 mm) deep and 6-13/16 inches (182 mm) wide with white paint finish and stamped 13-gauge steel end caps. UL approved "Suitable for use in environmental air space." Bottom closure panel forms slot for passage of viewing surface and can be released to hang down or be removed for access to operating mechanism and viewing surface. Bottom perimeter flange provides support and trim for acoustical ceiling panels and trim for gypsum board ceiling. The Access case may be ordered in advance and the screen installed later to eliminate field damage. Housing is symmetrical allowing for left and right hand motor locations and for viewing surface to unroll off front or back of roller. Steel mounting brackets slide in extruded aluminum mounting system along top of case. Brackets supporting roller/fabric assembly slide in tracks inside the top of the case, allowing viewing surface to be centered in case. Steel leveling brackets are attached to case to prevent deflection. Housing designed with internal junction box and plug-in wiring connections to allow housing to be installed and connected to building power supply separately from motor and viewing surface.
 1. Motor mounted inside screen roller on rubber isolation insulators. Motor UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
 2. Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db and is UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
 - a. Single station control rated 115V AC, 60 Hz with 3-position rocker switch with cover plate to stop or reverse screen at any point.
 - b. Multiple station control rated 115V AC, 60 Hz with 3-position rocker switches with cover plates to stop or reverse screen at any point. Automatic override allows only one signal to reach the motor when operated simultaneously.
 - c. Low voltage control unit with three button 24V switches and cover plate to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - d. Low voltage 24V control unit with hand held RF remote three button control switch to

stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.

- e. Key Operated power supply switch to control power to control system.
- f. Locking switch cover plate for limited access to three position switch.
- g. Key operated 3-position control switch rated 115V AC, 60 Hz to stop or reverse screen at any point.
- h. Key operated 3-position low voltage control switch rated 24V to stop or reverse screen at any point.
- i. Group low voltage control unit to control ____ motorized screens.
- j. Video Interface Control for use with equipment with a 115V switched outlet.
- k. Video Interface Control for use with equipment with a 12V switched outlet.
- l. Video Interface Control for use with equipment with a 6V switched outlet.
- m. Motor shall be right mounted.
- n. Motor shall be left mounted.

3. Projection Viewing Surface

- a. Matte White XT1000V - On Axis gain of 1.0. 180 degree viewing cone. GREENGUARD Gold certified. Available with or without black backing.
- b. Pure White XT1300V - On Axis gain of 1.3. 180 degree viewing cone. For use in situations where lighting is well controlled and where enhanced brightness is needed due to limited projector brightness. Available with or without black backing.
- c. Grey XH600V - On Axis gain of 0.6. Provides excellent contrast and color reproduction. GREENGUARD Gold certified. Maximum size 9 feet by 12 feet (275 cm x 366 cm). Available with or without black backing.
- d. Pearl White MH1500V - On Axis gain of 1.5. Matt white surface with reflective pearlescent coating with black backing. Maximum size 9 feet by 12 feet (275 cm x 366 cm).
- e. ReAct MS1000V - On Axis gain of 1.0. 60 degree viewing cone. Silver/grey surface provides superior performance in ambient light conditions, offers excellent contrast, optimal color rendition, and is fully HD compliant. Maximum size 79 inches by 140 inches (201 cm x 356 cm).
- f. ClearSound NanoPerf XT800V - On Axis gain of 0.8. 180 degree viewing cone. Acoustically transparent white PVC fabric with microscopic perforations. Not recommended for use in sizes less than 80 inches (203 cm) wide. Not recommended for viewing less than 10 feet (305 cm) from screen.
- g. ClearSound Perf XT900V - On Axis gain of 1.0. 180 degree viewing cone. Acoustically transparent. Flexible matt white perforated surface. Reasonable control of ambient light is recommended. Not recommended for use in sizes less than 80 inches (203 cm) wide. Not recommended for viewing less than 20 feet (610 cm) from screen.

- h. TecVision XH700X Grey - On Axis gain of 0.7. 180 degree viewing cone. Designed for blending applications on curved or flat screens where ambient light is present. Provides very good contrast and color reproduction. Imaging Science Foundation certified and 4K ready. Dark backing.
- i. TecVision XT1100X White - On-Axis gain of 1.1. 180 degree viewing cone. Designed for use when the projector brightness and size of screen require a minimal increase in gain. Imaging Science Foundation certified and 4K ready. Dark backing.
- j. TecVision XH900X Grey - On Axis gain of 0.9. 180 degree viewing cone. Provides very good contrast and color reproduction. Imaging Science Foundation certified. 4K ready. Dark backing.
- k. TecVision MS1000X Grey - On Axis gain of 1.0. 70 degree viewing cone. Provides excellent contrast and color reproduction. Performs well in ambient light. Imaging Science Foundation certified. 4K ready. Dark backing.
- l. TecVision XT1000X White - On Axis gain of 1.0. 180 degree viewing cone. Imaging Science Foundation certified. 4K ready reference screen surface for blending applications, precise resolution, and color accuracy. Dark backing.
- m. TecVision XT1300X White - On Axis gain of 1.3. 180 degree viewing cone. Imaging Science Foundation certified. 4K ready. Dark backing.
- n. TecVision XT1600X White - On Axis gain of 1.6. 180 degree viewing cone. Imaging Science Foundation certified. 4K ready. Dark backing.
- o. TecVision XT1800X White - On Axis gain of 1.8. 180 degree viewing cone. Imaging Science Foundation certified. Suited for active 3D or color combining passive 3D systems. 4K ready. Dark backing.
- p. CineFlex CH1200V - On Axis gain of 1.2. 60 degree viewing cone. Neutral grey rear projection diffusing surface. Provides high resolution and excellent contrast, even in lighted rooms. Recommended for use with low to medium output projectors.
- q. CineFlex XT600V - On Axis gain of 0.6. 180 degree viewing cone. White rear projection surface works well for edge matching or edge blending applications, and also for short throw rear projection. Reasonable control of ambient light is recommended.

- r. CineFlex MH800V - On Axis gain of 0.8. 78 degree viewing cone. Low gain flexible rear material. Designed for use with high light output projectors and wide audience seating pattern.

4. Tab-Tensioning System

- a. Viewing surface with integrated tabs and cable on each side of fabric to provide tension and ensure flat viewing surface. Viewing surface and tabs CNC cut as a single piece. Tabs RF welded to the back of viewing surface to prevent tab separation. Tab adhesives are not acceptable. Viewing surface inserted into aluminum bottom dowel. Warranted for 5 years against tab separation.

5. Viewing Area H x W

- a. HDTV Format (16:9). Black masking borders standard:

- 1) 133 inch (3378 mm) diagonal, 65 inches x 116 inches (1651 mm x 2947 mm).
- 2) 161 inch (4089 mm) diagonal, 80 inches x 140 inches (2032 mm x 3556 mm).
- 3) 184 inch (4674 mm) diagonal, 90 inches x 160 inches (2286 mm x 4064 mm).
- 4) 193 inches (490 cm diagonal, 94 1/2 inches x 168 inches (240 cm x 427 cm).
- 5) 220 inches (559 cm) diagonal, 108 inches x 192 inches (274 cm x 488 cm).

- b. 16:10 Format. Black masking borders standard.

- 1) 137 inch (3480) diagonal, 72-1/2 inches x 116 inches (1842 mm by 2946 mm).
- 2) 165 inch (4191 mm) diagonal, 87-1/2 inches x 140 inches (2223 mm by 3556 mm).
- 3) 189 inch (4800 mm) diagonal, 100 inches x 160 inches (2540 mm x 4064 mm).
- 4) 198 inches (503 cm) diagonal, 105 inches x 168 inches (267 cm x 427 cm).
- 5) 226 inches (574 cm) diagonal, 120 inches x 192 inches (305 cm x 488 cm).

- 6. Provide an extra screen drop with an overall screen drop of ____ feet (____ m) with top border matching viewing surface color.

- 7. Provide an extra screen drop with an overall screen drop of ____ feet (____ m) with a black masking top border.

- B. Access Fit/Series V: Electric motor operated, steel case. Ceiling-recessed, 18-gauge steel headbox, 5-1/8 inches (130 mm) deep and 4-7/8 inches (124 mm) wide with white paint finish and stamped 13-gauge steel end caps. UL approved "Suitable for use in environmental air space." Bottom closure panel forms slot for passage of viewing surface and can be released to hang down or be removed for access to operating mechanism and viewing surface. Bottom perimeter flange provides support and trim for acoustical ceiling panels and trim for gypsum board ceiling. The Access Fit case may be ordered in advance and the screen installed later to eliminate field damage. Housing is symmetrical allowing for left and right hand motor locations and for viewing surface to unroll off front or back of roller. Steel mounting brackets slide in extruded aluminum mounting system along top of case. Brackets supporting roller/fabric assembly slide in tracks inside the top of the case, allowing viewing surface to be centered in case. Steel leveling brackets are attached to case to prevent deflection. Housing designed with

internal junction box and plug-in wiring connections to allow housing to be installed and connected to building power supply separately from motor and viewing surface.

1. Motor mounted inside screen roller on rubber isolation insulators. Motor UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
2. Quiet Motor mounted inside screen roller on rubber isolation insulators. Motor operates at 44db. UL certified, rated 110-120V AC, 60 Hz, three wire, instantly reversible, lifetime lubricated with pre-set accessible limit switches.
3. Motor Screen Controls, UL certified.
 - a. Single station control rated 115V AC, 60 Hz with 3-position rocker switch with cover plate to stop or reverse screen at any point.
 - b. Multiple station control rated 115V AC, 60 Hz with 3-position rocker switches with cover plates to stop or reverse screen at any point. Automatic override allows only one signal to reach the motor when operated simultaneously.
 - c. Low voltage control unit with three button 24V switches and cover plate to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - d. Low voltage 24V control unit with hand held RF remote three button control switch to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - e. Low voltage 24V control unit with hand held IR remote three button control switch to stop or reverse screen at any point, built-in RF receiver, built-in Video Interface Control trigger for 3V-28V, RS232, and dry contact relays.
 - f. Key Operated power supply switch to control power to control system.
 - g. Locking switch cover plate for limited access to three position switch.
 - h. Key operated 3-position control switch rated 115V AC, 60 Hz to stop or reverse screen at any point.
 - i. 3-position low voltage control switch rated 24V to stop or reverse screen at any point.
 - j. Video Interface Control for use with equipment with a 115V switched outlet.
 - k. Video Interface Control for use with equipment with a 12V switched outlet.
 - l. Video Interface Control for use with equipment with a 6V switched outlet.
 - m. Motor shall be right mounted.
 - n. Motor should be left mounted.
4. Projection Viewing Surface
 - a. Matte White XT1000V - On Axis gain of 1.0. 180 degree viewing cone. GREENGUARD Gold certified. Available with or without black backing.

- b. Pure White XT1300V - On Axis gain of 1.3. 180 degree viewing cone. For use in situations where lighting is well controlled and where enhanced brightness is needed due to limited projector brightness. Available with or without black backing.
- c. Grey XH600V - On Axis gain of 0.6. Provides excellent contrast and color reproduction. GREENGUARD Gold certified. Maximum size 9 feet by 12 feet (275 cm x 366 cm). Available with or without black backing.
- d. Pearl White MH1500V - On Axis gain of 1.5. Matt white surface with reflective pearlescent coating with black backing. Maximum size 9 feet by 12 feet (275 cm x 366 cm).
- e. ReAct MS1000V - On Axis gain of 1.0. 60 degree viewing cone. Silver/grey surface provides superior performance in ambient light conditions, offers excellent contrast, optimal color rendition, and is fully HD compliant. Maximum size 79 inches by 140 inches 201 cm x 356 cm).
- f. ClearSound NanoPerf XT800V - On Axis gain of 0.8. 180 degree viewing cone. Acoustically transparent white PVC fabric with microscopic perforations. Not recommended for use in sizes less than 80 inches (203 cm) wide. Not recommended for viewing less than 10 feet (305 cm) from screen.
- g. ClearSound Perf XT900V - On Axis gain of 1.0. 180 degree viewing cone. Acoustically transparent. Flexible matt white perforated surface. Reasonable control of ambient light is recommended. Not recommended for use in sizes less than 80 inches (203 cm) wide. Not recommended for viewing less than 20 feet (610 cm) from screen.
- h. TecVision XH700X Grey - On Axis gain of 0.7. 180 degree viewing cone. Designed for blending applications on curved or flat screens where ambient light is present. Provides very good contrast and color reproduction. Imaging Science Foundation certified and 4K ready. Dark backing.
- i. TecVision XT1100X White - On-Axis gain of 1.1. 180 degree viewing cone. Designed for use when the projector brightness and size of screen require a minimal increase in gain. Imaging Science Foundation certified and 4K ready. Dark backing.
- j. TecVision XH900X Grey - On Axis gain of 0.9. 180 degree viewing cone. Provides very good contrast and color reproduction. Imaging Science Foundation certified. 4K ready. Dark backing.
- k. TecVision MS1000X Grey - On Axis gain of 1.0. 70 degree viewing cone. Provides excellent contrast and color reproduction. Performs well in ambient light. Imaging Science Foundation certified. 4K ready. Dark backing.
- l. TecVision XT1000X White - On Axis gain of 1.0. 180 degree viewing cone. Imaging Science Foundation certified. 4K ready reference screen surface for blending applications, precise resolution, and color accuracy. Dark backing.
- m. TecVision XT1300X White - On Axis gain of 1.3. 180 degree viewing cone. Imaging Science Foundation certified. 4K ready. Dark backing.
- n. TecVision XT1600X White - On Axis gain of 1.6. 180 degree viewing cone. Imaging Science Foundation certified. 4K ready. Dark backing.
- o. TecVision XT1800X White - On Axis gain of 1.8. 180 degree viewing cone. Imaging Science Foundation certified. Suited for active 3D or color combining passive 3D

systems. 4K ready. Dark backing.

- p. CineFlex CH1200V - On Axis gain of 1.2. 60 degree viewing cone. Neutral grey rear projection diffusing surface. Provides high resolution and excellent contrast, even in lighted rooms. Recommended for use with low to medium output projectors.
- q. CineFlex XT600V - On Axis gain of 0.6. 180 degree viewing cone. White rear projection surface works well for edge matching or edge blending applications, and also for short throw rear projection. Reasonable control of ambient light is recommended.
- r. CineFlex MH800V - On Axis gain of 0.8. 78 degree viewing cone. Low gain flexible rear material. Designed for use with high light output projectors and wide audience seating patterns.

5. Tab-Tensioning System:

- a. Viewing surface with integrated tabs and cable on each side of fabric to provide tension and ensure flat viewing surface. Viewing surface and tabs CNC cut as a single piece. Tabs RF welded to the back of viewing surface to prevent tab separation. Tab adhesives are not acceptable. Viewing surface inserted into aluminum bottom dowel. Warranted for 5 years against tab separation.

6. Viewing Area H x W:

- a. HDTV Format (16:9). Black masking borders standard.

- 1) 92 inch (2337 mm) diagonal, 45 inches x 80 inches (1143 mm x 2032 mm).
- 2) 100 inch (2540 mm) diagonal, 49 inches x 87 inches (1245 mm x 2210 mm).
- 3) 106 inch (2692 mm) diagonal, 52 inches x 92 inches (1321 mm x 2337 mm).
- 4) 110 inch (2794 mm) diagonal, 54 inches x 96 inches (1372 mm x 2438 mm).
- 5) 119 inch (3023 mm) diagonal, 58 inches x 104 inches (1473 mm x 2642 mm).
- 6) 133 inch (3378 mm) diagonal, 65 inches x 116 inches (1651 mm x 2947 mm).

- b. 16:10 Format. Black masking borders standard.

- 1) 94 inch (2438 mm) diagonal, 50 inches x 80 inches (1270 mm x 2032 mm).
- 2) 109 inch (2769 mm) diagonal, 57-1/2 inches x 92 inches (1461 mm x 2337 mm).
- 3) 113 inch (2870 mm) diagonal, 60 inches x 96 inches (1524 mm x 2438 mm).
- 4) 123 inch (3124 mm) diagonal, 65 inches x 104 inches (1351mm x 2642 mm).

- 7. Provide an extra screen drop with an overall screen drop of ____ feet (____ m) with top border matching the viewing surface.
- 8. Provide an extra screen drop with an overall screen drop of ____ feet (____ m) with a black masking top border.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which boxes, poke-thrus' fittings, and projection screens are to be installed and substrate that will support boxes. Notify the Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
 - 1. Do not begin installation until substrates have been properly prepared.
 - 2. Verify rough-in openings are properly prepared.

3.2 DOCUMENT INTERPRETATION

- A. The locations of the outlet symbols shown in the Drawings represent a close approximation of the exact location where the outlet shall be installed. This location may be shifted left or right eight inches to allow for stud alignment or coordination with electrical outlet locations. Approval by Owner is required for more extensive adjustments to outlet location.
- B. Outlet Schedule
 - 1. Refer to the outlet schedule contained [on the Drawings sheet XXX] for outlet mounting height, device box size, and station conduit size.

3.3 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.4 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
- B. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- C. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.
- D. Unused Openings: Close unused box openings using manufacturers recommended accessories.
- E. Provide a minimum concrete pour depth of 3-7/16-inch [87mm] plus 1/16-inch [1.6mm] above the top of the box for the RFB4, RFB4-4DB, RFB2, and the RFB2-OG Series Boxes; 2-7/16-inch [62mm] plus 1/16-inch [1.6mm] for the RFB4-SS and RFB2-SS Series Boxes; and 3-7/16-inch [87mm] plus 13/16-inch [21mm] above the top of the box for the RFB4-CI-1, RFB6, and RFB6-OG Series Boxes; and 4-1/16-inch [103mm] above the top of the RFB4E and RFB4E-OG Series Boxes; and 4-inch [102mm] above the top of the RFB6E and RFB6E-OG Series Boxes. Provide the box with four (4) locations to accommodate leveling for pre-concrete pour adjustment and include four (4) leveling screws for the pre-pour adjustment.
- F. The 6AT, and 6ATCFF units shall mount in a 6" [152mm] cored hole, actual 6 1/16" [154mm]

core hole. The 8AT units shall mount in an 8" [203mm] cored hole, actual 8 1/16" [205mm] core hole. Use is defined by the UL Fire Resistance Directory as a minimum spacing of "2 ft. [610mm] on center and not more than one device per each 65 sq. ft. [6m²] of floor area in each span".

1. Installation shall be completed by pushing unit down into the cored hole. Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer's instruction sheet included with each device. The unit shall contain a retainer for securing the device in the slab, as well as the necessary intumescent material to seal the cored hole under fire conditions.

G. Outlet Box Mounting:

1. Station cable boxes shall be 4-11/16" square x 3" deep regardless of cable count or cable type.
2. Height: unless otherwise noted in the Outlet Schedule, all communication outlet boxes shall be installed at the same height as electrical outlets, except WCP outlets, which shall be installed at 48 inches AFF to center of box.
3. Install boxes to accommodate device indicated by symbol, in conformance with code requirements and consistent with type of construction.
4. Install the appropriate work cover on all outlet boxes.
5. Set front edge of device box flush with the finished surfaces except on walls of noncombustible materials where the boxes may have maximum set back of 1/4". Secure flush-mounted box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
6. Set outlet boxes parallel to construction and independently attached to same.
7. Do not install back-to-back and through-the-wall boxes. Install with a minimum 6" horizontal separation between closest edges of the boxes. Install with minimum 24" separation in acoustic rated walls.
8. Outlet boxes for audiovisual shall be in a separate box from electrical outlets.

H. Box Support:

1. Mount boxes straight and plumb.
2. Install stud support one side, with short piece of stud, for up to 2-Gang device boxes.
3. Do not support boxes with tie-wire.
4. For one- and two-gang box support, manufactured bracket supports shall be accepted alternate.
5. Support boxes independently of raceways.
6. Install adjustable steel channel fasteners for hung ceiling outlet boxes.
7. Install stamped steel bridges to fasten flush-mounted junction box between studs.
8. Do not install boxes to ceiling support wires or other piping systems.

9. When boxes are installed in fire-resistive walls and partitions, provide 24" horizontal separation between boxes on opposite sides of a wall. In addition, limit penetrations to 16 square inches per penetration and not to exceed a total of 100 square inches per 100 square feet of wall area. Apply fire stop putty or muffins acceptable to the authority having jurisdiction (AHJ).

I. Projection Screen Installation

1. Install in accordance with manufacturer's instructions.
2. Install front projection screens with screen cases in position and relationship to adjoining construction as indicated, securely anchored to supporting substrate, and in manner that produces a smoothly operating screen with plumb and straight vertical edges and plumb and flat viewing surfaces when screen is lowered.
3. Test electrically operated units to verify that screen, controls, limit switches, closure and other operating components are in optimum functioning condition.

3.5 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect boxes and fittings until acceptance.

3.6 STORAGE AND HANDLING

- A. Schedule delivery to minimize delays in the project.
- B. Provide storage protection against temperature and humidity extremes, theft, vandalism, physical damage, and environmental damage.

END OF SECTION

SECTION 27 4116

AUDIO VISUAL SYSTEMS

PART 1 - GENERAL

1.1. SUMMARY

- A. This document covers the general requirements for the installation of audiovisual (AV) systems for the Health Science and Human Services Building Project located at Midwestern State University, Wichita Falls, Texas.

1.2. RELATED DOCUMENTS

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

1.3. CODES

- A. Execute work in accordance with best AV system installation practices, National Electrical Code, and applicable state and local codes.

1.4. REGULATIONS

- A. Comply with terms and conditions of Americans with Disabilities Act, especially regarding provisions for hearing impaired and wheelchair access in control areas.

1.5. SUBMITTALS

- A. General
 - 1. Refer to Division 1.
 - 2. Submit in quantities, format and timetable as required by General Conditions.
- B. Product Data Binders
 - 1. Minimum number of Sets: four (4).
 - 2. Timetable
 - a. Submit within thirty (30) days after award of contract.
 - b. Submit simultaneously with Shop Drawings.
 - c. Allow minimum of ten (10) business days for review. All sets minus one (1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contractor shall reimburse Owner for expenses incurred during additional review process.
 - d. Review and approval of Product Data is required before equipment purchase and installation.
 - e. Bind product data sheets together either in GBC or 3-ring type binders.
- C. Shop Drawings
 - 1. Minimum Number of Sets: four (4).
 - 2. Timetable
 - a. Submit within thirty (30) days after award of contract.
 - b. Submit simultaneously with Product Data Binders.
 - c. Allow minimum of ten (10) business days for review. All sets minus one (1) will be returned with review comments. If a resubmit is required, resubmit total quantity of complete sets. If second resubmit is required, Contract shall reimburse Owner for expenses incurred during additional review process.

3. Description:
 - a. Shop Drawings shall be used for coordination between trades and updated as final record drawings.
 - b. Bind all Shop Drawings together to form set. Loose drawings will not be accepted.
 - c. Each drawing shall include: Project, Building, Location, Contractor Name, Architect, AV Consultant, Date and Revision Number.
 - d. Number and title each drawing in logical manner as a set.
 - e. Include cover sheet with listing of all drawings included in bound set.
 - f. Ensure that labeling on Shop Drawings match labeling on equipment.
 - g. Minimum Scale:
 - 1) Floor Plans: 1/8 inch = 1 foot.
 - 2) Rack Elevations: 1-1/2 inch = 1 foot.
 - 3) Plate/Panel Details: 6 inches = 1 foot.
 - 4) Loudspeaker Details: 1 inch = 1 foot.
 - h. Include as a minimum:
 - 1) Floor plans indicating locations of all AV devices, vertical risers, pull boxes, and exposed wiring. Include Device ID (PRJ, SCREEN, FRK, FB, AVP, etc., as referenced in design contract documents), as appropriate for projectors, screens, racks, floor boxes, AV plates in walls, etc.
 - 2) Schematic diagram showing all primary and secondary devices, interconnectivity and signal flow.
 - 3) Plate details showing size, material, finish, connectors, engraving, etc.
 - 4) Mounting detail drawings of loudspeakers, racks, and overhead equipment. Hire services of professional structural engineer, licensed by the appropriate governing authority, to review shop drawings, building structural drawings, and any existing structures from which equipment is to be suspended. Include Structural Engineer's stamped report with shop drawing submittal. Report shall include:
 - i. Itemization of items reviewed by the Structural Engineer.
 - j. Confirmation that proposed methods of suspending equipment as shown on the shop drawings conform to required safety factors.
 - k. Confirmation that building structure from which equipment is to be suspended will support equipment including required safety factors.
 - 1) Rack elevations.
 - 2) Complete schematic diagram. One-line diagram with detailed descriptions of product inputs and outputs is acceptable. Include terminal strip details and cable label information. If wiring diagram spans more than three (3) sheets, additionally provide simplified block diagram of entire system on one (1) sheet.
 - 3) Electrical power wiring diagram. Include circuit, switching, and control details.
 - 4) Wiring diagram of grounding and shielding scheme.
 - 5) Drawings for custom-fabricated items (i.e., plates, panels, cables, and assemblies).
 - 6) General construction drawings necessary for completion of work.

D. Operation and Maintenance Manuals

1. Minimum number of Sets: four (4).
2. Bind Operation and Maintenance Manuals using either GBC or 3-ring binders.
3. Format and Minimum Information below:
 - a. Section 1 - System Operation.
 - 1) Introduction/overview to system components and their functions and locations. Include a brief listing of basic system functions.
 - 2) Complete but simple system operating instructions to accomplish basic system functions, written for non-technical personnel.

- 3) Certificate indicating names of Owner personnel trained by AV Contactor, date of training, name of AV Contractor representative that provided training, and name of project.
- b. Section 2 - System Documentation.
 - 1) Simplified system one-line schematic diagram showing changes made during construction.
 - 2) Complete inventory of system components including serial numbers. Identify location (equipment rack, over stage, stored in control room, etc.) of each component.
 - 3) Cable and terminal strip documentation including cable numbers, functions, originating locations, terminating locations, and signal levels.
 - 4) All Shop Drawings corrected to reflect as-built conditions.
 - 5) Other data and drawings required during construction.
 - 6) Initial Tests and Adjustments data.
 - 7) Final Tests and Adjustments data.
 - 8) CD-ROM discs including all utilized manufacturer's software and saved copies of software configurations (configurations as established during Final Tests and Adjustments).
- c. Section 3 - Manufacturer's Documentation.
 - 1) For each equipment model at no additional costs to Owner, even if manufacturer does not include costs of such documentation with purchase of equipment item.
 - 2) Manufacturer's Product Data.
 - 3) Operating instructions.
 - 4) Installation instructions.
 - 5) Service information.
 - 6) Schematic diagrams.
 - 7) Replacement parts list.
- d. Section 4 - Maintenance Information.
 - 1) Preventive maintenance schedule letter clearly stating target dates of six month and end-of-warranty preventative maintenance inspections, and list of maintenance tasks performed.
 - 2) Maintenance instructions including manufacturer's recommended maintenance, recommended maintenance schedule and information concerning proper inspection, testing, and replacement of components.
 - 3) Troubleshooting information complete with instructions for procedures during equipment failure.
- e. Section 5 – Warranty Information
 - 1) System warranty letter.
4. Provide three (3) sets on CD-R disc that include all material in Operation and Maintenance Manuals in PDF format except for copyrighted material.
5. Submit one (1) set of Operation and Maintenance Manuals at least ten (10) days before Final Tests and Adjustments procedures (minus data from Final Tests and Adjustments). This set will be reviewed by Owner and returned to Contractor. Re-submit after Final Tests and Adjustments and include data. NOTE: Do not schedule Final Tests and Adjustments or perform training of Owner personnel before submitting Operation and Maintenance Manual.
6. Submit remaining number of complete manuals as required by General Conditions within ten (10) days after return of reviewed set(s). Include Final Tests and Adjustment data, warranty period letter, and any other data not included in first submission.

E. Samples

1. Request for Samples - Upon request, furnish samples (at no additional cost) to Owner and/or General Contractor of submitted items proposed as substitutes for specified items. Products will be reviewed to determine if proposed substitute items meet required function and quality.

2. Product Tests
 - a. Products submitted as samples may require testing by independent laboratory. Testing at expense of Contractor.
 - b. Obtain written approval of tested products before incorporating into system.

1.6. QUALITY ASSURANCE

- A. AV Contractor Qualifications
 1. Be established AV System Contractor, regularly engaged in furnishing and installing AV systems. NOTE: Electrical or general contracting firms responsible for completion of this work, but not meeting above requirement, shall employ services of approved AV Contractor as subcontractor to perform work described herein.
 2. Be experienced in installations of similar size and scope within last five (5) years. Submit list of four (4) (minimum) installed jobs of similar magnitude, completed within last five years. For verification, submit complete information, including project name, project address, contact person, daytime telephone number plus month and year of project completion. At Owner's request, accompany Owner or Owner's representative on visit to any or all example completed projects submitted.
 3. Be Authorized Dealer for all major lines of equipment listed in Part 2 (Biamp, Sony, Crown, Sharp, Crestron, etc.) Must have at least one permanent staff member who is factory trained in the installation and maintenance of each major product line offered.
 4. Employ personnel (at all levels of work) experienced in projects of similar size and scope. Provide list of key personnel to be responsible for each of the following aspects of work: Project Management, Technical Documentation, Control System programming, DSP programming and Leadership of Field Work (one who is present for all field work). For each identified employee, indicate number of years employed by contractor, number of years' experience in assigned responsibilities, and list of previously completed projects where similar responsibilities were required.
 5. Project manager assigned to this project must have a minimum of five (5) years' experience in installing and integrating AV systems of similar scale. Project Manager shall also have either an INFOCOMM CTS-I or CTS-D certification.

PART 2 - PRODUCTS

1.1. GUIDELINES

- A. All active AV equipment shall be furnished by AV Contractor selected by the Owner. All active electronics shall be contractor furnished, contractor installed (CFCI).
- B. Infrastructure Products – All conduits, basket tray/cable tray, pull boxes and associated parts required for infrastructure shall be installed by the electrical contractor unless specifically excluded in these specifications or drawings.
- C. Performance - Regardless of completeness of descriptive paragraphs herein, each device shall meet its manufacturer's published specifications. Verify performance.
- D. Contract Documents - Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general, the specifications determine the nature and quality of the materials, and the drawings establish the quantities, details, and give characteristics of performance that should be adhered to in the installation of the AV system components. If there is an apparent conflict between the drawings and specifications, the items with the greater quantity or quality shall be provided and installed. Clarification with the owner about these items shall be made prior to the ordering and installation.
- E. Quantities – All quantities are indicated on AV drawings or in Part 2 AV Products list. Confirm quantities on final Contract Documents. If Contract Documents do not include quantities necessary to deliver complete working system, provide notification of disparity, and install required quantity of devices for complete working system.

- F. Small Parts - Systems are described in terms of major products. Even if not specifically mentioned, provide and install patch cables, connectors, hardware, converters, power supplies, labels, terminals, mounting accessories etc. necessary for complete and working system meeting design intent of specifications.
- G. Balanced Lines – Unless specifically directed otherwise, wire all line and microphone level circuits as balanced with respect to signal ground. For products without balanced inputs or outputs, provide high quality balancing transformers with proper level, shielding, and impedance characteristics. Assure all audio levels arriving and leaving matrix and routing switchers are equal to the manufacturer's recommended input audio level. If required, use Radio Design Labs, Inc. products or equivalent for level matching.
- H. Keys - Provide five (5) sets of keys for any AV system product requiring keys.
- I. Condition – Provide and install products listed in this section in factory new condition, conforming to applicable provisions of American National Standards Institute.
- J. Designations - Each major product item is given unique designation (such as MIX1 for mixer number 1). The product designations are unique in this section only and may be repeated in other specification sections.
- K. Security Screws - Use Middle Atlantic HSK Guardian Series button-head screws and bits to secure rack components, LCD mounts, Projector mounts and any other location deemed necessary by Owner. Use nylon washers (not provided by Bryce) to protect equipment surfaces. Account for appropriate tip wear when ordering quantity and do not use a bit beyond the manufacturer's recommendations. Provide ten (10) additional unused driver bits and deliver to the customer after completion.
- L. AV Electrical Power - Ensure that "Star" ground configuration is properly implemented by the Electrical Contractor. Ensure that ground wires from each outlet are isolated from conduit, neutrals, and each other and are each home-run back to the dedicated breaker panel for AV systems.
- M. Wireless Microphones - Coordinate frequency selection with other radio-frequency sources in the area and with manufacturer's recommendations.
- N. Control System Programming:
 - 1. Program each panel to provide simple, intuitive control of all basic AV functions including: per zone program and speech volume levels, video source and destination routing, AV system power, media player transport functions and CATV tuner control (including channel guide, navigation, last channel, channel select (up, down and manual input) and channel presets).
 - 2. Utilize InfoComm International's "Dashboard for Controls" concept for touch panel layout unless directed otherwise by Owner.
 - 3. Control system shall be integrated into Crestron's Fusion management system allowing the Owner to manage and control the building's AV systems and provides reports on system usage, down time and other reportable attributes as requested by Owner.
 - 4. AV management software shall be installed on Owner furnished computer(s) with adequate specifications per manufacturer's recommendations.
 - 5. Provide layout of each and every touch panel and hard-button panel pages in the product data submittal for approval by Owner.
 - 6. Provide web-control for each touch panel in AV system. Include page tracking, and track current button feedback between touch panel and web-control panel.
 - 7. Staff member certified by control system manufacturer shall program control system. Control programming must be done by in-house personnel. Programming cannot be subbed out to another contractor or individual.
 - 8. After programming is approved, all control system code and programming, including touch panel code and graphics, will become property of Owner. AV Contractor shall provide Owner both raw and compiled code on CD-R disc.

- O. Audio System Programming - Owner shall coordinate layout and logical branching of DSP audio system. Include screen layout and menu branching drawings in AV submittal. After AV system is approved, all audio control system code and programming will become property of Owner. AV Contractor shall provide Owner both raw and compiled code on CD-R disc.
- P. EDID Configuration – The variety of resolutions of laptops and other computer devices that may be connected to these systems is unknown. Set preferred EDID settings to 1920x1080, 60Hz, 2-channel audio.
- Q. AV Racks:
 - 1. Provide blank faceplate in any area marked BLANK in drawings.
 - 2. Provide shelf for mounting of any device for which rack mount kit is not available.
 - 3. Provide one Panelcrafters DATCO-XXXXX-RHIM-01 designer/integrator information plate or approved alternate per rack. Install information plate at the top of each rack unless 1RU space is not available. Contact Panelcrafters sales department to add AV Contractor graphic to the “integrator” section (approximately 8.5” x 1.75” of the right-hand side). All alternates must include AV Consultant graphic. Submit to AV designer for approval of final plate design prior to purchasing and installation.
- R. AV Floor Boxes and Poke-thrus:
 - 1. Clean floor boxes and poke-thrus of all dust and debris prior to installation of any active or connectorized plate.
 - 2. Any floor box or poke-thru with active or connectorized AV plates found to have any dust, debris or water in bottom of box are subject to replacement of all plates and components. A re-test of all associated components must be completed.
 - 3. Provide blank plates for all unused compartments in the AV floor boxes and poke-thrus.
- S. AV Plates
 - 1. The project standard plate color is white unless the plate is mounted on a wood or stone wall in which case it is to be stainless steel.
- T. AV Design Bid & Substitutions:
 - 1. System design is around products listed in Part 2. Intent of product specification is to provide standard of quality and function for installed materials. Certain performance specifications are given to clarify job requirements.
 - 2. Bid AV system with products specified in section below unless noted otherwise from Owner.
 - 3. No substitutions will be allowed without prior approval from Owner specific to proposed manufacturer and model numbers.
 - 4. Equipment listed in Part 2 is based on performance criteria to meet Owner design requirements.
 - 5. All requested substitutions need to meet or exceed performance of devices listed in Part 2. For each request provide manufacturer’s published specifications to verify performance and explain functional and cost impact.
 - 6. Evaluation and approval of substitution requests will be performed by Owner.

1.2. ROOM DESCRIPTIONS

- A. Conference / Debriefing Rooms (#202, #352, #446): Each room will have a wall mounted flat panel display. ~~The two (2) debriefing rooms~~ **Debriefing Room 202** will have existing interactive boards with **existing wall mounted projector**. A wired input at the table via cable cubby and a wired input at the wall to support owner furnished devices are provided. **USB extender will be provided from interactive board in room 202 to table.** Speech reinforcement and program audio will be accommodated via ceiling mounted loudspeakers. An output for a portable assistive listening system will be included per ADA requirements. Control of the flat panel will be via wall mounted control keypad.

- B. Classrooms Typical (#101, #302, #304, #306, #332): Each classroom will be flexible with multiple displays to allow for multiple configurations. All the wall mounted flat panel displays can be fed the same input source or discrete sources. Sources for display include wired inputs at the lectern via cable cubby and at the wall to support owner furnished devices, a wireless presentation system for display of presenter or participant devices (e.g. laptops or tablets), a document camera, a cable television tuner (cable service feed by others) and a dedicated owner furnished room computer. All equipment will reside in the local lectern. A wired "button" microphone at the lectern and a wireless microphone system for use throughout the room will provide speech reinforcement. Program audio and speech reinforcement will be accommodated via ceiling mounted loudspeakers. An assistive listening system will be included per ADA requirements. Control will be handled via a touchscreen control panel mounted to the lectern. Intuitive controls via graphic touch panel interface will control system power, program audio source selection and volume control, plus lighting presets and shade control (if available).
- C. Dental Lab 103A/103B: This instructional lab is a large dividable room with a movable partition. Each lab classroom will have a local lectern housing a wireless presentation system for display of presenter or participant devices (e.g. laptops or tablets), a document camera, a cable television tuner (cable service feed by others) and a dedicated owner furnished room computer. A wired input at the lectern via cable cubby to support an owner furnished device will be provided. A wired "button" microphone at the lectern and a wireless microphone system for use throughout the room will provide speech reinforcement. Program content will be presented with a motorized projection screen and a ceiling mounted video projector. An assistive listening system will be included for each classroom per ADA requirements. Control will be handled via a touchscreen control panel mounted to the lectern. Intuitive controls via graphic touch panel interface will control system power (including screen up and down), program audio source selection and volume control, plus lighting presets and shade control (if available). In the large room configuration with wall partition opened, the presentation content can be distributed from either lectern position.
- D. Nursing Skills Lab #2: This instructional lab will have a local lectern housing a wireless presentation system for display of presenter or participant devices (e.g. laptops or tablets), a document camera, a cable television tuner (cable service feed by others) and a dedicated owner furnished room computer. A ceiling mounted PTZ camera in a dome mount will be mounted in instructional area for close-ups of demonstrations of equipment or working with a manikin. A wired input at the lectern via cable cubby to support an owner furnished device will be provided. A wired "button" microphone at the lectern and a wireless microphone system for use throughout the room will provide speech reinforcement. Program content will be presented on ceiling mounted projection screen and ceiling projector (OFE), on an interactive white board via ceiling mounted video projector. A wired input and output at the wall will provide source input and content output to the portable interactive white board. An assistive listening system will be included per ADA requirements. Control will be handled via a touchscreen control panel mounted to the lectern.
- E. Radiologic Sciences Lab: This instructional lab will have a local lectern housing a wireless presentation system for display of presenter or participant devices (e.g. laptops or tablets), a document camera, a cable television tuner (cable service feed by others) and a dedicated owner furnished room computer. A wired "button" microphone at the lectern and a wireless microphone system for use throughout the room will provide speech reinforcement. Program content will be presented with Wall mounted interactive white board (OFE) via ceiling mounted video projector. A wired input and output at the wall will provide source input and content output to a portable interactive white board. An assistive listening system will be included per ADA requirements. Control will be handled via a touchscreen control panel mounted to the lectern.
- F. Respiratory Care Skills Lab: This instructional lab will have a local lectern housing a wireless presentation system for display of presenter or participant devices (e.g. laptops or tablets), a

document camera, a cable television tuner (cable service feed by others) and a dedicated owner furnished room computer. A wired input at the lectern via cable cubby to support an owner furnished device will be provided. A wired "button" microphone at the lectern and a wireless microphone system for use throughout the room will provide speech reinforcement. Program content will be presented with a motorized projection screen via ceiling mounted video projector. A large flat panel display will also be provided to present supplementary program content. An assistive listening system will be included per ADA requirements. Control will be handled via a touchscreen control panel mounted to the lectern.

- G. Anatomage/Virtual Lab: This instructional lab will have wired inputs at the center table via cable cubby to support owner furnished devices. A dedicated owner furnished room computer and HDMI extenders will be housed in the equipment cabinet under the anatomage table. Program content will be presented with one (1) fixed wall mount projection screen (2 x 1 configuration) and ceiling mounted video projectors. Ceiling speakers connected to the PC will provide any program audio. A wall mounted 5" touch panel connected to control system will provide control of system.
- H. Classroom with ITV Distance Learning (#240): Each classroom will be flexible with multiple displays to allow for multiple configurations. All the wall mounted flat panel displays can be fed the same input source or discrete sources. Sources for display include wired inputs at the lectern via cable cubby and at the wall to support owner furnished devices, a wireless presentation system for display of presenter or participant devices (e.g. laptops or tablets), a document camera, a cable television tuner (cable service feed by others) and a dedicated owner furnished room computer. All equipment will reside in the local lectern. A wired "button" microphone at the lectern and a wireless microphone system for use throughout the room will provide speech reinforcement. Program audio and speech reinforcement will be accommodated via ceiling mounted loudspeakers. An assistive listening system will be included per ADA requirements. Control will be handled via a touchscreen control panel mounted to the lectern. Intuitive controls via graphic touch panel interface will control system power, program audio source selection and volume control, plus lighting presets and shade control (if available). An Add Alternate provides additional equipment for ITV Distance Learning from this room. Displays have been optimized for this use. An additional Codec with a camera in the rear of the classroom as well as the front. Overhead microphones will be added for audience response. A DSP audio processor will need to be added to handle the additional microphones.
- I. Dean's Conference Room (#411): Each room will have a wall mounted flat panel display. A wired input at the table via cable cubby and a wired input at the wall to support owner furnished devices are provided. Speech reinforcement and program audio will be accommodated via ceiling mounted loudspeakers. An output for a portable assistive listening system will be included per ADA requirements. Control of the flat panel will be via wall mounted control keypad.
- J. Student Lounge 140: Lounge will have Infrastructure for future wall mounted flat panel display for showing cable television (cable television feed by others) and/or digital signage (see below). Control will be handled via the flat panel display's remote.
- K. Digital Signage: Each digital signage location will have a wall mounted flat panel display. A small form factor, IP addressable PC will be located at each panel for pushing content from an owner provided signage system.

1.3. AV PRODUCTS

A. The following are major active and infrastructure products for this project.

1. AMP – Power Amplifier
 - a. Type 1 – Extron ~~MPA 152 70V 15watt~~ **MPA 601 60 watt** audio amplifier with rack mount kit
 - b. Type 2 – Extron XPA 2001 70V 100wattt audio amplifier with rack mount kit
2. AVP – AV Input Plate
 - a. Type 1 – Custom one-gang AV plate with one (1) HDMI passive connector to be Extron WPD 110 A
 - b. Type 2 – Custom one-gang AV plate with one (1) DTP transmitter and one (1) microphone input (XLR)
 - c. Type 3 – Custom two-gang AV plate with one (1) **DTP USB** transmitter and one (1) DTP receiver
3. AVT – Tuner
 - a. Aurora VTUNE PRO 4K/QAM/NTSC/IPTV Tuner
 - 1) Include manufacturer recommended rack mount kit
4. CAM – PTZ Video Camera
 - a. Type 1 - Polycom EagleEye Director II auto tracking camera.
 - 1) Provide with cable extenders and adaptors as required to connect to CODEC **(ADD Alternate #5 only)**.
 - 2) Provide with wall mount that will house all the parts required at the camera location.
 - b. Type 2 – Vaddio RoboShot 12 HDBT (ceiling mounted) with OneLink HDMI Extension module.
 - 1) Provide the Vaddio 12” clear indoor flush mount dome
5. CC - Cable Cubby
 - a. Type 1 – Extron Cable Cubby 202 with pass-through plates
 - 1) Coordinate exact mounting location with architect
6. CDC – Videoconferencing Codec **(ADD Alternate #5 Only)**
 - a. Polycom RealPresence Group 700 CODEC.
 - b. Provide with rack mount and required adaptors, power supplies to provide complete system.
7. **CMIC – Ceiling microphone (ADD Alternate #5).**
 - a. **Shure MXA910W-60CM Ceiling Array microphone With IntelliMix DSP Suite.**
 - b. **Dante Audio out.**
 - c. **Provide with PoE power supply to power system.**
8. CP – Control Processor
 - a. Type 1 – Extron IPCP Pro 250 control processor.
9. DOC – Document Camera
 - a. Type 1 - Wolfvision VZ-3 desktop visualizer
10. DSP – Digital Signal Processor
 - ~~a. Type 1 – Shure DFR22~~
 - b. Type 2 – Extron DMP 128 Plus C **V AT (ADD Alternate #5 only)**.
 - 1) Use Extron Electronics ASA 131 passive audio summing adapters for incoming balanced stereo audio signals.
 - 2) **Provide with AEC, Dante and VOIP features.**
11. DSPC – Digital Signage PC
 - a. Black Box ICKS-VE-KU-N K Series VESA Digital Signage Player.
12. FPD - Flat Panel Display
 - a. Type 1 – Samsung DM82E-BR 82” flat panel display
 - 1) Include Chief Manufacturing XSMU1 wall mount
 - 2) Include active unbalanced to balanced audio converter for audio output
 - b. Type 2 – Samsung DM65E-BR 65” flat panel display
 - 1) Include Chief Manufacturing XSM1U wall mount

- 2) Include active unbalanced to balanced audio converter for audio output
- c. Type 3 – Samsung DM75E-BR 75" flat panel display
 - 1) Include Chief Manufacturing XSM1U wall mount
 - 2) Include active unbalanced to balanced audio converter for audio output
- d. Type TV/DS and DS – Samsung DM55E 55" flat panel display
 - 1) Include Chief Manufacturing MSM1U wall mount
 - 2) Include active unbalanced to balanced audio converter for audio output
- 13. FRK – Floor Rack
 - a. Middle Atlantic ERK-4425
 - 1) Power strip for appropriate power distribution
 - 2) Middle Atlantic caster base
 - 3) Middle Atlantic ERK-4QFT-FC fan top
 - 4) Middle Atlantic D Series Drawer
 - 5) Middle Atlantic vents and blanks as indicated on the drawings
- 14. IWB – Interactive White Board
 - a. Type 1 – OFE existing portable Prometheus Boards with built-in short throw projector.
 - b. Type 2- OFE existing wall mounted Prometheus Board utilizing new type 4 2 ceiling mounted projector. USB extender to be mounted in FPD back box.
 - c. **Type 3 – OFE existing wall mounted Prometheus Board with existing wall mounted projector.**
- 15. LA - Listening Assist System
 - a. Listen LT82-01 IR Transmitter with:
 - 1) Listen LA-140-WH IR emitter- white.
 - 2) Listen LA-326 Transmitter rack mount kit
 - 3) Listen LA-364 Recharging station
 - 4) Provide four (4) Listen LR-44 receivers with two (2) LA-164 over the ear headphones and two (2) LA-166 Neck Loop.
- 16. LECTERN
 - a. SoundCraft MWSU – LECTERN 32 Custom Lectern with Logo. Match University standard finish. Submit sample to Architect.
 - 1) Include rack rails.
 - 2) Include cutouts for the cable cubby and microphone.
 - 3) Include sliding keyboard and mouse tray.
 - 4) Include casters with brakes.
 - 5) Include document camera shelf.
 - 6) Include Monitor arm to be installed at site.
 - 7) Finish: Charcoal Grey Carpet.
- 17. NET – Network Switch
 - a. HP 5120-EI-24G-PoE+ gigabit ethernet switch
- 18. PMIC – Lectern Microphone
 - a. Clear One 910-103-162 "button" microphone with shock mount.
 - 1) Secured to lectern top. Coordinate mounting with architect and consultant.
 - 2) Coordinate mounting with architect
- 19. PRJ - Video Projector
 - a. Type 1 - Panasonic PT-RZ660BU (6500 lumens) with appropriate lens
 - 1) Include Chief Manufacturing RPA universal ceiling projector mount
 - 2) Include Chief Manufacturing CMS adjustable extension column and CMA plate
 - b. Type 2 – Panasonic PT RZ575BU (5200 lumens) with appropriate short throw lens
 - 1) Include Chief Manufacturing RPA universal ceiling projector mount
 - 2) Include Chief Manufacturing CMS adjustable extension column and CMA plate.
 - c. **Type 3 – Existing wall mounted projector.**

20. PSW – Presentation Switcher
 - a. Type 1 - Extron DTP Crosspoint 108 4K all-in-one presentation switcher
 - 1) Use Extron Electronics ASA 131 passive audio summing adapters for incoming/outgoing balanced stereo audio signals.
 - 2) Include RS-232 extenders for cable runs over 50 feet.
 - b. Type 2 - Extron DTP Crosspoint 84 4K all-in-one presentation switcher
 - 1) Use Extron Electronics ASA 131 passive audio summing adapters for incoming/outgoing balanced stereo audio signals.
 - 2) Include RS-232 extenders for cable runs over 50 feet.
21. PWR - Power Management
 - a. Type 1 - Middle Atlantic PDC-915R-6 power supply
 - b. Type 2 – Middle Atlantic UPS-2200R-IP uninterruptable power supply.
22. S – Loudspeaker
 - a. Extron FF-220T Full-Range Flat Field
 - 1) Tap at 7.5 watts.
 - 2) Follow manufacturer's guidelines to paint speakers to match architect provided color sample
23. TP - Control Touch Panel
 - a. Type 1 – Extron TLP Pro 520M wall mount 5" touch panel
 - 1) Coordinate color with architect
 - 2) Include PoE injector connected to building LAN
24. UPS – Uninterruptable Power Supply
 - a. APC SMT1000RM2U Smart UPS 1000VA RM @U 120V.
 - 1) Mount in bottom of each Lectern.
25. UTP Rx – Digital Twisted Pair Receiver
 - a. Type 1 - Extron DTP HDMI 4K 230 Rx DTP receiver
 - b. Type 2 – Extron DTP HDMI 4K 230 D Rx DTP receiver (decora style)
26. UTP Tx – Digital Twisted Pair Transmitter
 - a. Type 1 - Extron DTP T UWP 232 D two input DTP transmitter (decora style)
 - b. Type 2 - Extron DTP T HWP 4K 231 D DTP transmitter (decora style)
27. USB Rx – Digital USB Twisted Pair Receiver
 - a. Real prType 1 – Extron USB Extender Plus R USB Extender Receiver
28. USB Tx – Digital USB Twisted Pair Transmitter
 - a. Type 1 – Extron USB Extender Plus T USB Extender Transmitter
29. WCP – Wall Mounted Control Panel
 - a. Type 1 – Extron TLP Pro 520M wall mount 5" touch panel
 - 1) Coordinate color with architect
 - 2) Include PoE injector connected to building LAN
 - b. Type 2 – Extron EBP 100 wall mount push button control panel
 - 1) Include PoE injector connected to building LAN
 - 2) Coordinate color with architect.
 - c. Type 3 – Extron MLC Plus 84D Media Link Controller (Decora Style)
 - 1) Coordinate color with Architect
 - 2) Power unit from power outlet behind Flat Panel Display.
 - 3) Connect RS232 directly to Flat Panel Display.
30. WMIC – Wireless Microphone
 - a. Shure ULXD Single Receiver System
 - 1) Extend antenna as necessary for full coverage within each system's corresponding room.
 - 2) Provide Shure UA864US ceiling mounted antennas when extending.
 - 3) Provide Shure ULXD1 body pack with MX153 earset head-worn microphone.
 - 4) Provide Shure ULXD2/SM58 hand-held transmitter.
 - 5) Provide with charging station and rechargeable batteries

31. WPS – Wireless Presentation System
 - a. OFE Apple TV
 - 1) Include Middle Atlantic RSH4A2S custom rack shelf.
32. SCREEN - FIXED – Wall mounted fixed stretched projection screen Anatomage Room (303) only.
 - a. Draper Clarion wall mounted fixed stretched screen.
 - 1) Size: 208" W x 65" T Frame (dual 16:10 images).
 - 2) Projection Material: OptiFlex Matt White XT1000V.
 - 3) Provide additional frame support trusses as required.
 - 4) Provide wall mount brackets.

1.4. CABLES

- A. Interconnect Wiring – All AV cables will be plenum rated per NEC.
 1. Analog Audio Plenum Rated Cable - West Penn 25291, or similar.
 2. Digital Audio Plenum Rated Cable: Belden 1801B plenum-rated AES/EBU compliant equivalent.
 3. Analog Composite Video Plenum Rated Cable: West Penn 25806 or Belden 89120.
 4. RGBHV Plenum Rated Cable: Belden 1283S5, or West Penn 258195.
 5. Control Plenum Rated Cable: West Penn D25350.
 6. Loudspeaker Plenum Rated Cable: West Penn 25226B & 25227B.
 7. Shielded Cat7a Cable: Crestron DM-CBL-ULTRA
 8. Fiber 62.5 μ m Cable: Corning 62.5/125.
 9. Interface/Adapter Cables: AMX or Extron Certified Cables
 10. HDMI Interconnect Cables: Extron Pro Series HDMI Cables
- B. Connectors – All AV (including microphone) connectors shall be made by Canare or Neutrik. Connectors shall be of the quantity and type as required for proper and durable operation, and signal transmission of the electrical characteristics for associated circuitry.
 1. Microphone connectors: 3-conductor XLR AES/EBU compliant (for microphones in tables/lecterns, use Neutrik RF shielded connectors).
 2. Control panels: XLR type with number of conductors as required.
 3. Line level and left/right audio connectors: tip/ring/sleeve 1/4" phone jacks with insulated bushings.
 4. Composite video and RGBHV connectors: BNC dual crimp true 75 ohm BCP-C.
 5. BNC shall be made by ADC or Kings and be HD-SDI compliant to 3 GHz.
 6. Fiber: UniCam LC connectors.
 7. Loudspeaker shall be Neutrik Speakon type.
 8. Provide strain relief for each and every connector.

PART 3 - EXECUTION

1.1. INSTALLATION

- A. General Guidelines
 1. Quality of Work - Perform labor to accepted industry standards and state and local codes to accomplish complete and working system.
 2. Material and Labor - Provide specified products and other incidental materials, appliances, tools, and transportation required for complete and functioning systems. Provide personnel to perform labor who are skilled in techniques and can demonstrate technical knowledge AV infrastructure system installations.
 3. Documents at Job Site - Keep following documents at job site during entire construction period:
 - a. Complete Specifications and Drawings.
 - b. Approved Shop Drawings.
 - c. Approved Product Data.

- d. Progress Set of Project Record Documents.
 4. Mounting - Mount equipment and enclosures plumb and square. Ensure that permanently installed equipment is firmly and safely held in place. Design equipment supports to support loads imposed with project safety factor of five (5) or greater. For devices hung overhead, obtain review by Structural Engineer licensed by the appropriate governing authority prior to installation.
 5. Dimension Verification - Verify dimensions and space requirements to assure that proper mounting, clearance, and maintenance access space is available for system components.
 6. Clean-Up - Leave project clean each day. Place debris where designated by General Contractor. Debris includes but not limited to: solder splatter, cable ends, stripped insulation, spent crimp connectors, gypsum board and ceiling tile dust, and product wrappings and cartons. After completion of installation, thoroughly clean areas worked, including non-visible areas such as equipment rack interiors, rack top panels, and inside lockable floor and wall boxes.
 7. Coordinate installation of AV infrastructure and equipment with other trades in order to follow project schedule.
 8. Maintain any licensing required by the appropriate governing authority to install and terminate low voltage systems.
- B. Labeling
1. Equipment Labels - AV Contractor shall provide engraved lamicoïd labels on front and rear of rack-mounted equipment. Mount labels plumb and square. Include schematic reference design, item name, and system or area controlled by labeled component. On program preamps and mixers, provide label for each input indicating which source is controlled by labeled channel. Unless otherwise indicated, provide permanently-mounted black labels engraved with 1/8-inch white block characters. Handwritten, self-laminating, or embossed plastic (Dymo) labels are not acceptable. Provide labels for major equipment with two (2) lines (minimum) of engraving, coded as follows:
 - a. Line 1: Generic name of device, such as MIXER AMPLIFIER.
 - b. Line 2: Schematic designation of device, such as AV-MSW-1.
 2. Control Labels - AV Contractor shall provide engraved label over each user-operated control that describes the function or purpose of control. Provide label of proper size to fit available space.
 3. Terminal Strip Labels - AV Contractor shall label each terminal strip with unique identification code in addition to numerical label (Cinch MS series) for each terminal. Show terminal strip codes on system schematic drawings included with Project Record Documents.
 4. Rear Equipment Labels - AV Contractor shall provide adhesive label on rear of equipment where cables attach, to indicate designation of cable connected at each point.
 5. Cable and Wire Labels - Label cables and wiring logically, legibly and permanently for easy identification. Labels on cables shall be adhesive strip type, covered with clear heat shrink tubing. Factory stamped heat shrink tubing may be used. Hand-written or self-laminating type labels are not acceptable.
 6. Cable Label Codes and Locations - Label each cable with unique alpha-numeric code. Locate cable designation at start and end of each cable run, within three (3) inches of termination point. For cable runs that have intermediate splice points, label cable with same designation throughout, with additional suffix to indicate each segment of run. Provide cable designation codes to schematic drawings included with Project Record Documents and Operation and Maintenance Manuals.
- C. Power and Grounding
1. Power Coordination - Coordinate final connection of power and ground wiring to rack. Electrical contractor will provide power to audio visual systems. Before installation, verify load requirements for systems as accepted.
 2. Bus Bars - Install 1-inch by ¼-inch copper ground bus bar, top to bottom in floor mounted AV racks. Ground and bond equipment chassis of each rack-mounted component

without three-pin grounding plug to bus bars with #12 AWG insulated green wire using 6-32 or larger nuts, bolts, lock-washers, and appropriate NEMA connectors. Electrical Contractor (Division 16) shall provide and connect #4 AWG green insulated wire from Bus Bars to ground point in AV technical electrical panel.

D. Equipment Racks

1. Ventilation - Provide ventilation adequate to keep temperature in rack below 85 degrees Fahrenheit. Use "whisper" type ventilation fans in racks, adjusted to come on when temperature in rack rises above 85 degrees Fahrenheit, only if adequate cooling cannot be provided by Owner.

E. Wiring

1. Wiring Standards - Execute wiring in strict adherence to best AV engineering practices.
2. Field Connection Devices - Connect cable to active components through screw terminal connections and spade lugs when appropriate. For BNC connections use three-piece, dual crimp BNC properly sized for cable with insulating bushings. Wire nut or "Skotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape. Punch connectors or telephone-style punch blocks are not acceptable anywhere in the installation unless specifically authorized by Owner.
3. Run cable in ceiling plenums neatly parallel to building walls, supported every three feet to structure with plenum rated ties.
4. Raceways - Run vertical wiring inside rack in Panduit (or equivalent) plastic raceways with snap-on covers, sized to allow at least 50% future wiring. Mount raceways on full length ¾-inch flat black plywood backboards, attached to rack sides. If between-rack wiring chases are provided, Panduit raceways are not required. Horizontal wiring in rack shall be neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack, but still allow for service and testing. Provide horizontal support bars if cable bundles sag. Individually bundle excess AC power cable away from rack mounted equipment with plastic cable ties. Electrical tape and adhesive backed cable tie anchors are not acceptable.
5. Accessibility - Ensure that wiring and connections are completely visible and labeled in rack. Mount termination resistors, if required, on terminal strips, fully visible and not concealed within equipment or connectors.
6. Loudspeaker Polarity - Connect loudspeakers electrically in phase, using same wire color for loudspeaker wiring throughout project.
7. Physical Damage Prevention - Take necessary precautions to prevent physical damage to cables and equipment. Damaged cables or equipment will not be accepted. Separate, organize, and route cables to restrict channel crosstalk and feedback oscillation.
8. Racks - Looking into the rack from the rear, locate AC power, control, data and speaker wiring on the left; line level audio, control, video, and RF wiring on the right. Keep several inches of space between power cables and other signals.
9. Hum Prevention - Ensure that electromagnetic and electrostatic hum is at inaudible levels. For line level signals, float cable shields at the output of the source device. Do not cut or remove shield conductors; fold back unconnected shields over cable jacket and cover with clear heat-shrink tubing. Do not obstruct cable labels.
10. Other Connections - Make connections using rosin core solder or approved mechanical connectors. Where spade lugs are used, crimp properly with ratchet type crimping tool. Solder spade lugs mounted on #22 AWG or smaller cable after crimping.

1.2. STORAGE AND HANDLING

- A. Power up any electronic equipment to ensure its proper functioning before its arrival onsite.
- B. Ensure that materials (especially electronic and electro-acoustic devices) are protected against physical, environmental, and electronic damage until final acceptance by Owner.

- C. Schedule delivery to minimize delays in the project.
- D. Provide storage protection against temperature and humidity extremes, theft, vandalism, physical damage, and environmental damage.

1.3. WARRANTY

- A. Refer to Division 1.
- B. Warranty - Submit letter providing warranty covering labor and materials supplied under this contract. Bind in Operation and Maintenance Manuals. Terms as described in General Conditions. Minimum terms as follows:
 - 1. System - Systems shall be free of manufacturing or installation defects for a minimum period of one (1) year from the date of final acceptance. Clearly designate begin and end dates of system warranty period.
 - 2. Parts and Labor - Provide parts and labor to repair defects in materials and workmanship during system warranty period.
 - 3. Response Time - Within system warranty period, provide initial on-site service response within one (1) business day of service call. Provide resolution to any system defects within 72 hours or within 48 hours of receipt of repaired or replaced product from manufacturer.
 - 4. Replacement Products - If any item must be removed for repair during system warranty period, provide replacement item of similar quality at no charge.
 - 5. Repair Limit - Do not repair any piece of equipment found defective during installation or system warranty period more than two (2) times. After second repair, replace defective item with similar approved item at no additional cost to Owner.
 - 6. Extended Manufacturer's Warranties – Identify products with manufacturer's warranties extending beyond one (1) year. Provide terms and conditions of such warranties.
 - 7. Service Personnel Information - Provide name(s) and telephone number(s) of service personnel to be contacted regarding repair and maintenance.
- C. Extended Warranty - Provide cost to extend complete AV system warranty from one (1) year to three (3) years. Included a list of all provided services including maintenance schedules.

1.4. INITIAL TESTS

- A. Purpose – These tests are to ensure that the AV system is installed and functioning as specified, and to ensure the system is ready for Final Tests and Adjustments (described later).
- B. Testing Standards – Perform testing in accordance with ANSI standards.
- C. Inspection - Verify prior to beginning actual tests and adjustments on systems:
 - 1. Proper grounding of all electronic components (through third prong of power connector or separate connection between component chassis and ground bus bar).
 - 2. Cables dressed, routed, and labeled, connected with proper polarity.
 - 3. Insulation and shrink tubing in place.
 - 4. Dust, debris, solder splatter, etc. removed.
 - 5. Proper frequency settings (or modules) at crossovers and controllers.
 - 6. All equalizer bands and tone controls set for flat frequency response.
 - 7. Survey temperatures of each piece of equipment after four (4) hours use (minimum). Note and report any hot equipment.
- D. Electrical Power Quality - While all sound and AV system components are unplugged from electrical power outlets, AV Contractor shall turn on power to outlets, and confirm proper voltages at each outlet across the following pairs of terminals: hot and neutral, hot and ground, and neutral and ground (zero volts across neutral and ground). AV Contractor to document measurements.

- E. General Function Tests - Test each piece of equipment to ensure that it performs its intended function. Include all portable equipment in tests. Intent of initial tests is to verify complete, functioning system before Final Tests and Adjustments. Correct problems found during initial testing before beginning Final Tests and Adjustments. Document whether all pieces performed intended functions; note any unresolved malfunctions.
- F. Initial Tests and Adjustments Data - Submit written report of Initial Tests and Adjustments data upon completion to Owner. Include printed name(s) of technician(s) performing tests, date(s) and time(s) of tests, model and serial numbers of test equipment, results of each initial test, descriptions of problems encountered and their solutions, and statement that system is ready for Final Tests and Adjustments. Initial Tests and Adjustments Data to include signatures of technician(s) performing tests.

1.5. FINAL TESTS AND ADJUSTMENTS

- A. Purpose – These tests are to be witnessed by AV Consultant to determine if system is complete and functioning as designed and specified. Also, AV Consultant will perform listening and viewing tests and witness adjustments of all images for optimum clarity.
- B. Timetable - Coordinate with Owner, General Contractor, and AV Consultant to schedule Final Tests and Adjustments after submittal of Initial Tests and Adjustments data.
- C. System and Site Conditions – AV Consultant will witness Final Tests and Adjustments. Have systems fully functional and ready for observation and testing upon AV Consultant's arrival. Coordinate with all trades for quiet conditions throughout the listening areas and for the duration of the test schedule. If upon AV Consultant's arrival, systems do not meet criteria, site is not sufficiently quiet, or if Owner or AV Consultant is required to make additional trips to job site to witness additional testing or perform additional reviews of installed equipment, Contractor shall reimburse Owner for labor and expenses incurred by having incurred costs deducted from payments to contractor.
- D. Test Labor - Provide technician familiar with this project's AV systems and operation of test equipment to perform testing. Provide additional technician to assist in the tests and to perform troubleshooting, repairs, and adjustments. Include labor for these technicians to be present for one (1), eight (8)-hour day during Final Tests and Adjustments.
- E. Tools - Provide standard hand tools including screwdrivers, pliers, wire strippers, nut drivers, soldering iron, and other tools appropriate for troubleshooting system problems.
- F. Ladders and Scaffolds - Provide ladders and scaffolds to inspect/adjust loudspeakers and rigging points.
- G. Verification of Initial Tests and Adjustments - Verify that Initial Tests and Adjustments have been performed and meet criteria. During Final Tests and Adjustments, AV Consultant may require portions of the Initial Tests and Adjustments to be repeated. Repeat measurements as requested without claim for additional payment.

1.6. FINAL ACCEPTANCE BY OWNER

- A. Certificate – Submit Certificate of Final Acceptance form signed by Owner verifying complete installation and proper operation of systems upon fulfillment of all requirements and upon recommendation by Owner.
- B. General Adjustments – Adjust, balance, and align equipment for optimum quality, meeting manufacturers published specifications.
- C. Input/Output Jack Demonstration – Demonstrate proper performance and phase of each system input and output jack (all audio input and output jacks) as received at AV and network systems.
- D. Inventory – Inventory all installed and portable equipment for correct quantities.

- E. Functional Demonstration – Demonstrate operation of each function of each major piece of equipment.
 - F. Other Tests - Perform any other tests on any part of the AV system as requested by Owner.
 - G. Final Equipment Settings – Record final settings of all equalizer bands, tone controls, filters, delays, limiters, etc., including those established through computer software settings. Include descriptions of settings (including software settings) in Operation and Maintenance Manual. Include software copy of configuration file(s) in Operation and Maintenance Manual.
 - H. Security Inspection – Inspect equipment for security from tampering (covers, shaft-locks, etc.).
 - I. Review of Labels – Review installed labels on cables, equipment, controls, and terminal strips.
- 1.7. OWNER TRAINING
- A. Provide Owner training as described in General Conditions. As a minimum, provide twelve (12) hours instruction (within four (4) trips to site) regarding AV Systems operation to Owner-designated personnel. Schedule instruction time(s) with Owner to occur after completion of Final Tests and Adjustments. Coordinate with Owner in advance to schedule instruction time. Document date, time, and attendees of the training session and include documentation in Operation and Maintenance Manuals to serve as record of trained personnel.
- 1.8. SUPPORT DURING OWNER'S FIRST USE OF COMPLETED SYSTEM
- A. Provide personnel familiar with design, installation, and operation of each system to be present at Owner's first use of each completed system (up to six (6) hours total in two sessions). During first use of each system, respond to Owner requests for troubleshooting, adjustments, and additional training. If no one contractor employee or representative can provide expertise in all aspects of the system, provide multiple personnel for the six (6) hours per session as required. Schedule presence of personnel in advance with Owner. Should significant elements of the new system be operational prior to final completion, Owner may elect to schedule contractor presence for Owner function prior to final completion of system. Should Owner exercise this option, contractor presence will not be required at first use following final completion.

END OF SECTION 27 41 16

SECTION 280000

ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 PROJECT SUMMARY/OVERVIEW

- A. This document covers the general requirements for work to be performed to provide electronic security and surveillance.
- B. The contents of this document, along with related drawings and other documentary material, are critical to the security of this project and Owner and shall remain secure and confidential.
 - 1. Confidential information shall not be deliberately or inadvertently disclosed to anyone other than the Contractor's personnel and subcontractors who require disclosure to perform their portion of the work.
 - 2. This confidential information shall be tracked to ensure that copies are accounted for and properly destroyed when no longer needed to perform the work.
- C. The security systems shall consist of the following integrated subsystems as specified herein:
 - 1. Electronic Access Control and Intrusion Detection
 - 2. Video Surveillance
 - 3. Emergency Intercommunications and Duress
 - 4. Wire and Cable
- D. Provide complete turnkey systems with the exception of those items noted within this specification as being provided by others.
- E. Related Sections include:
 - 1. Section 087100 Door Hardware
 - 2. Section 142000 Elevators (including related sub-sections)
 - 3. Section 260000 Electrical (including related sub-sections)
 - 4. Section 270000 Communications (including related sub-sections)
 - 5. Section 281000 Electronic Access Control and Intrusion Detection
 - 6. Section 282300 Video Surveillance
 - 7. Section 282600 Emergency Intercommunications and Duress
 - 8. Section 283100 Fire Alarm and Smoke Detection

1.2 GENERAL REQUIREMENTS

- A. Upon completion of commissioning testing and Owner acceptance, DataCom Design Group bears no liability or responsibility for the continued proper operation of the installed systems.
- B. Upon completion of commissioning testing and Owner acceptance, DataCom Design Group bears no liability or responsibility for the continued proper operation of the installed systems.

- C. The Items described herein shall not be modified or substituted without consent of DataCom Design Group and/or the Owner.
- D. Electronic security systems integrator (security subcontractor) manager/supervisor shall attend meetings arranged by the Contractor, Architect, Owner or other parties affected by the work of this Section 280000.
- E. If the manufacturer of security devices or connecting hardware has supplied post manufacture performance data, copies of such are to be kept for inclusion in the documentation and made available to the Owner upon request.
- F. All materials are to be new unused and of the latest series of model number, unless otherwise indicated by the Owner or security system designer.
- G. All security integrator personnel must be manufacturer certified and capable of an installation that falls under the manufacturer's guidelines necessary to obtain a manufacturer warranty.
 - 1. The integrator shall provide all components/materials essential for a complete and functional security access and surveillance system.
- H. Security integrator shall issue a two (2) year warranty on installation and workmanship.
- I. These Specifications and Drawings are intended for bidding purposes only, No part shall be copied or used for any purpose other than bidding on this project.
 - 1. This package shall be contractual upon bid award.
- J. Drawings and Specifications are to be used in conjunction with one another and to supplement one another.
 - 1. In general Specifications determine the nature and quality of the materials and tests, and drawings establish the quantities, details and give characteristics of performance that should be adhered to in the installation of the security system components.
 - 2. If there is an apparent conflict between the drawings and specifications, or within the specifications themselves, the items with greater quantity or quality shall be estimated and installed.
 - 3. Clarification with the Owner/Designer about these items shall be made prior to purchase and installation.
 - 4. Questions regarding the Specification or system requirements should be directed in writing to DataCom Design Group or the Owner.
- K. Security integrator shall adhere to Division 1 general requirements and written security Specifications and Drawings within this construction package and shall be responsible for complying with all local, state and federal laws or regulations applicable to the work being performed, even though said law, rule or regulation is not identified herein.
- L. Security integrator shall arrange and pay for any inspections required by the public agencies having jurisdiction in the area.
- M. The security contractor shall procure and maintain for the duration of this agreement, insurance against claims for injuries to persons or damages to property which may arise from, or conjunction with, the performance of the work hereunder by the security integrator, his agents, representatives, or employees.

1. The security integrator shall pay the cost of such insurance.
- N. The security integrator will respect and protect the privacy and confidentiality of the Owner, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State of Texas and the Owner.
- O. If required the security integrator shall sign a non-disclosure agreement and abide by its requirements to keep confidential all information concerning bid documents and this Project.
- P. Furnish submittals and manuals in accordance with Division 1.
- Q. Furnish a detailed material list complete with suppliers (distributors) list of components and distributors name, address, and phone number.
- R. Refer to Specifications issued by Architect, Division 1, for Project and cost payments.

1.3 REFERENCES

- A. The publications listed below form a part of this Specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in Specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. For conflicts between referenced requirements and contract documents comply with the one that is more stringent.
1. Federal, State, and Local codes, regulations and ordinances
 2. NFPA 101: Life Safety Code
 3. NFPA 72: National Fire Alarm Code
 4. NFPA 730: Guide for Premises Security
 5. NFPA 731: Standard for the Installation of Electronic Premises Security
 6. National Electric Code (NEC), latest edition
 7. Building Codes (UBC) (IBC), latest editions
 8. Occupational Health and Safety Act (OSHA)
 9. Americans with Disabilities Act (ADA)
 10. Local Governing Authorities Having Jurisdiction
 11. Underwriters Laboratory (UL) Applicable Standards for Safety and Security
 12. Institute of Electrical and Electronics Engineers (IEEE) Applicable Standards
 13. Telecommunications Industry Association (TIA) Applicable Standards
 14. Midwestern State University standards for Security Systems
- D. Related Documents
1. Security Drawings
 2. General provisions of contract
 3. Uniform general conditions
 4. Supplementary general conditions
 5. Architectural plans & specifications
 6. Requirements of Division 1
 7. Electrical / Mechanical / Telecommunications specifications and plans.

1.4 DESCRIPTION OF SYSTEM WORK

- A. Furnish and install all materials, tools, equipment, and services for all electronic security/surveillance devices to provide functioning systems in accordance with performance requirements specified and any modifications resulting from reviewed shop and field coordinated drawings.

1. Access Control System

- a) This system replaces the typical mechanical key controlled door lock with a door locking system that uses an access card as the access credential.
- b) The system includes an electric door-locking mechanisms, card reader located adjacent the door, door status sensor, door prop alarm and a request to exit device.
- c) Typical system configuration is card or schedule controlled entry with free exiting.

2. Intrusion Detection System

- a) This system monitors areas for unauthorized entrance or intruder.
- b) This system can consist of motion sensors, door status sensors, glass break sensors and one or more control keypads.
- c) The keypad is used to arm/disarm system by entering a numeric code on the keypad.

3. Video Surveillance System

- a) This system is used to provide video surveillance through the use of cameras of security sensitive areas and target items.
- b) The system shall allow for the viewing and recording of images.

4. Emergency Intercommunications and Duress Systems

a) Duress Buttons

- 1) These buttons, also known as panic buttons, are installed in locations where potential personal safety or security threats exist.
- 2) Depressing the button sends a silent priority alarm signal to assigned monitor with location and specific alarm information
- 3) The panic button is usually located in the knee space underneath a desk or service counter.

b) Emergency Phone / Intercom / Call Stations

- 1) The device typically is a distinct box or pole with a call button.
- 2) Depressing the call button puts the individual in direct voice contact with assigned monitor along with specific location information.

B. RACKS AND ENCLOSURES

- 1. Wall mounted enclosures, data gathering panels, and power supply panels shall be installed as per manufacturer's requirements.
 - a) Coordinate pathways and power with Electrical and Telecommunications Contractors

- b) Furnish all labor, materials, tools, equipment, and services for all control consoles, equipment racks, cabinets, and enclosures not provided by others in accordance with contract documents.
 - c) Completely coordinate with work of other trades to avoid duplication in purchasing.
 - d) Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
- 2. The installation of the relay racks/cabinets for Electronic Surveillance shall be coordinated with the Telecommunications Contractor and G.C.
- 3. The designated security space will provide an area reserved for rack and wall mounted security equipment.
 - a) The rack area allows for vertical relay rack(s).
 - b) Backboard wall area of 8'-0" X 8'-0" shall be reserved for wall-mounted components.
 - c) Cable tray/ ladder shall be by the telecommunications contractor and is provided to facilitate cable access into both wall and rack mounted equipment.
- C. Provide all supplementary or miscellaneous items and devices incidental to or necessary for a sound and complete installation.
- D. Drawings are representative and show general arrangement of systems and equipment, except when dimensioned or detailed.
 - 1. For exact locations refer to dimensioned architectural drawings.
 - a) Field measurements take precedence over dimensioned drawings.
 - b) Field verify locations and arrangement of all systems and equipment.
 - c) Coordinate all work with other trades and Contractor.
- E. Circuit Supervision
 - 1. Supervise all signal and data transmission lines, links with other systems, and sensors.
 - a) Indicate circuit and detection device faults with both protected zone and trouble signals.
 - b) Initiate an alarm in response to opening, closing, or shorting of a signal or data transmission line.
- F. Electronics systems work as specified in this Section and Sections 281000, 282300, 282600 shall include:
 - 1. A project kick-off/pre-submittal meeting with the Architect, Designer, and Contractor to review security design package.
 - a) Additional participants shall include:
 - 1) Division 8 subcontractors
 - 2) Division 14 subcontractors
 - 3) Division 26 subcontractors

2. Preparation of pre-installation submittals, including point-to-point wiring information for security equipment to interface to work by others prior to start of any installation work. Include lock permit requests in submittals for review.
3. Furnishing and installation of all security devices, components and accessories.
4. The furnishing and coordination on installation of special back boxes for security equipment and field devices as required.
5. Furnishing, installation and termination of all copper wiring and cabling including any special purpose wire and cable for electronic security systems.
 - a) Coordinate all network and fiber optic cable interface provided by telecommunications subcontractor.
6. Coordinate raceway and power distribution systems provided by Division 26.
7. Provide and install 12/24 VAC/DC input power to all field devices as required.
8. Coordination with other trades and Owner required to facilitate the installation of the security equipment including:
 - a) Division 08 (doors)
 - b) Division 26 (power, raceways, and fire alarms)
 - c) Division 14 (elevator controls)
 - d) Division 27 (telecommunications network interface).
9. Wiring and termination of electrified door hardware by security subcontractor shall be concurrent with the installation of these electrified components by the door hardware subcontractor.
10. Programming of all security control equipment and prior coordination with the Owner's security and telecommunications personnel.
11. Preparation of "As-Built" documentation.
12. Warranty service for completed work.

1.5 SUBMITTALS

- A. Refer to Requirements of Division 1.
- B. Pre-Installation Submittal Requirements
 1. Submittals for electronic security shall be complete and submitted at the same time.
 - a) No partial submittals will be accepted for review.
 - b) Allow 2 weeks for consultant review of submittals.
 2. General Requirements
 - a) A functional description of each system.
 - b) All cable and wiring types for each device type used.
 - c) Certification that lock wiring and access control systems requirements have been coordinated with electrified door hardware, fire alarm systems, automatic door controls, and overhead door controls specified in other sections and other packages.
 - d) Power supply points listing with devices and maximum loads to prevent overloading.
 - e) Battery backup calculations to show load and back-up times for UPS and power supplies with batteries.

- f) Equipment schedules listing all system components, manufacturer, model number and quantities of each.
- g) Qualifications and proof of work history (with references).

3. Product Data Cut-sheets

- a) Complete manufacturer's technical data including manufacturer warranty information, descriptive literature, illustrations, and installation instructions for all components included within this project indicating compliance with applicable referenced standards, size, dimensions, model number, electrical characteristics, support requirements, connection requirements and all applicable information verifying that submitted components comply with Contract Documents.

4. Shop Drawings

- a) Floor plans necessary to identify specific device locations, cable routes and quantities, cable types, riser locations, and references to installation details and diagrams.
- b) Riser diagram showing routes between floors or other areas that are not easily identified on the floor plans.
- c) Security One-line diagrams showing all input and output points of the system.
 - 1) The Contractor shall make any corrections required by the consultant team, file with him two corrected copies and furnish such other copies as may be needed.
 - 2) The consultant's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless he has in writing called the Architect's attention to such deviations at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings or schedules.
- d) Release of CAD Files
 - 1) Contractor may request to utilize DataCom's AutoCAD floor plan files for assistance in producing shop drawings.
 - 2) Request shall be made by signing DataCom's "Agreement for Release of CAD Files" letter.

5. Warranty

- a) The Contractor shall provide the appropriate documentation to comply with the requirements described in the WARRANTY section.

6. Qualifications

- a) The Contractor shall provide the appropriate documentation to comply with the requirements described in the QUALITY ASSURANCE section.

C. As-Built drawings shall be in current AutoCAD format, same version as used by the Architect.

- 1. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing used for the contract documents, and shall include the following.

- a) Utilize normally recognized drafting procedures that match AutoCAD standards, Architect, and Designer guidelines and methodology.
 - b) The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, Addenda, contemplated change notices, Site Instructions or deviations resulting from site conditions.
 - c) Dimensioned plan and elevation views of all security components.
 - d) Cable routing paths of security cables to identified infrastructure pathways.
 - e) All rack, cabinet, and enclosure locations and labeling thereof.
 - f) One-line diagrams of equipment/device interconnecting cabling of the security systems.
 - g) Standard or typical installation details of installations unique to Owner's requirements.
 - h) Submit one soft and one hard copy with project deliverables within 30 days of project completion.
- D. Security integrator shall provide three (3) paper copies and one (1) electronic copy (PDF format) of a properly indexed O&M Manual at the conclusion of the project, which will include, but not be limited to the following requirements:
- 1. Ring binder with project title, properly indexed, and contractor's name on cover and spine including:
 - a) Sequence of operations, design philosophy, and specific functions
 - b) System block diagram
 - c) Equipment list including:
 - 1) A brief description
 - 2) Model
 - 3) Total number of each item used in the project.
 - d) Camera schedule including:
 - 1) Number
 - 2) Location
 - 3) Camera model/manufacturer
 - 4) View
 - 5) Lens
 - 6) Power source
 - 7) Multiplexer/input
 - 8) Settings entered on site
 - e) Manufacturers' data sheet and O&M manual for associated equipment.
 - f) Maintenance requirements for equipment, inspections and preventative maintenance schedules.
 - g) As-built drawings for each floor plan layout and rack and wall elevation layouts. Each drawing shall show:
 - 1) Cable type and identifier
 - 2) Actual cable routing pathway
 - 3) Device number (camera, etc.),
 - 4) Device input/output number.
 - h) Final test data (measured video levels, day & night camera snapshots in JPEG format and other significant operating parameters).

- i) List of system associated mechanical locking keys with key codes and tamper resistant hardware types.

1.6 QUALITY ASSURANCE

- A. Only approved security contractors may perform work on the CBORD system at Midwestern State University.
 - 1. List of approved security contractors:
 - a) **Blackhawk Integration**
 - 1) (325) 651-5733
 - 2) (325) 829-5127
- B. Electronic security systems integrator (security subcontractor) shall meet the following minimum requirements.
 - 1. Maintain a valid Type B license from the Texas Private Security Bureau.
 - 2. Have successfully completed three (3) projects of similar size and complexity that have been in proper operation for a period of one (1) year.
 - 3. Technicians shall be factory trained and certified in specified systems.
 - 4. The Project manager and supervising/lead technician shall have been regularly engaged in the installation and testing of the products specified for not less than five (5) years and maintain manufacturer certification.
 - 5. The security integrator must maintain an operating facility in the local area (50 mile radius) of the Project location to provide service to the Owner for the warranty period.
 - a) At the Owners request for service, the security integrator shall dispatch a service technician to the location to affect the required repairs or adjustments.
 - 6. The contractor shall maintain a spare parts inventory necessary to resolve component failures of the system.
 - a) Refer to individual specification section for a list of specifically required parts provided to the owner and stored on site. These parts will become the property of the owner.
 - 1) At the end of the warranty period the security integrator shall test the owner's spare parts and repair or replace as needed to bring the parts up to proper operation.
- C. Security integrators desiring approval must comply with Division 1 requirements.
- D. Security integrator must be cognizant of site conditions, verify locations of new and existing equipment, and determine exact requirements for connection and interface.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Equipment and components shall be delivered properly protected and undamaged with original containers, packaging, and labels intact.

- B. Store, handle, and protect all related materials and equipment in accordance with Manufacturer's recommendations.
- C. Provide additional protection during handling as necessary to prevent breaking, scraping, marring, or otherwise damaging products or surrounding areas.
- D. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
 - 1. Equipment damaged prior to system acceptance shall be replaced at no cost to the owner.
- E. Protect all equipment and components that are to be installed from theft, vandalism, or use by unauthorized persons.

1.8 PROJECT/SITE CONDITIONS

- A. Security integrator is responsible for conducting a site survey prior to the commencement of work to determine locations of all existing security devices and verify the proposed locations of the new components to be installed.
- B. Security integrator will coordinate all work through the Contractor and schedule work to cause as little interference or interruption of existing services as possible.
- C. Security integrator will arrange and pay for all necessary permits, licenses, and inspections.
 - 1. Security integrator shall prepare all information necessary to obtain a permit for Electronic Locking Mechanisms in compliance with the Owner requirements.
- D. Verify with Division 26 installer all conduits and special back box requirements in a timely manner.

1.9 WARRANTY

- A. See requirements in Division 1 Specifications.
- B. The Security Integrator shall warrant all completed work, including all materials and labor, to be free from defects in design, workmanship, and/or materials for a period of two (2) years from final acceptance date.
 - 1. System acceptance is defined as the completion of all functional performance testing and the resolution of all punch list items.
- C. Warranty Service
 - 1. In the event that defects in the materials and/or workmanship are identified during the warranty period, the contractor shall provide all labor and materials to correct the deficiency.
 - 2. All service work shall be performed by factory certified technicians.
 - 3. All warranty service shall include the replacement of all parts and or components as required to restore normal system operation.

- a) If parts or components need to be repaired, a loaner will be supplied and installed until the part or component can be repaired and reinstalled.
- 4. Immediately following a warranty service request, the Contractor shall provide written documentation to Owner which details the service work completed, cause of trouble, and any outstanding work required to restore a complete and normal system.
- D. Warranty service requests shall be responded to within 4 hours of notification with a qualified service technician on site.
- E. All repairs shall be completed within 48 hours upon site arrival.
 - 1. If the failure exceeds 48 hours, the Owner reserves the right to require the contractor provide on-site manufacturer support at no additional cost to Owner.
- F. Extended warranties on equipment components offered by the manufacturer shall be passed through to the Owner.
 - 1. Warranty provisions shall be fully transferable only at the direction of the Owner, in the event that ownership of the installed security systems is transferred.

1.10 SYSTEMS STARTUP AND TRAINING

- A. After all systems have been tested, accepted and turned on for operation, the Security integrator shall provide "User Training" to Owner personnel.
 - 1. The onsite training shall cover all newly installed electronic security components, devices and systems. The training classes shall total a minimum of twelve (12) hours for up to four (4) people of the Owner's choosing.
 - 2. Two (2) separate training sessions will be conducted, one for system operators and one for system administrators.
 - 3. The contents of the manuals will include:
 - a) Title page with subject, system name, owner's name, and an owner approved confidentiality notice.
 - b) Table of contents.
 - c) Manual that details system and sub-system operation.
 - d) Manuals that details system administration procedures and tasks.
 - e) Manuals that fully detail all programming commands.
 - 4. Provide two (2) Bound hardcopy System Administration training manuals and one electronic copy (PDF format).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer's are shown in individual specification sections.

- B. Equipment manufacturers and model numbers indicated in individual specification sections are identified as minimum equipment requirements.
- C. All substitutions shall meet or exceed these minimum requirements and must be approved by the Owner/Architect prior to purchase.
- D. All manufacturers' equipment shall be available through a nationally recognized supplier network.

2.2 EQUIPMENT

- A. Provide security fasteners on all equipment, device plates, etc. within public areas.
 - 1. Allen head with center pin, hardened steel.
 - 2. Provide four (4) fastener tools to Owner.
- B. Equipment installed in exterior applications shall be fitted with fasteners and exposed surfaces of stainless steel or other corrosion resistant material.
- C. All materials and equipment used must be new and unused, prime quality products.
- D. All equipment or components installed on the exterior of a building where the equipment is subject to adverse weather/elements shall be enclosed in weatherproof enclosures.

2.3 WIRE AND CABLE

- A. All wire and cable shall be U.L. approved for its intended application and shall meet or exceed manufacturer's recommendations for the components connected.
- B. All conductors and cable shall meet individual security system manufacturer specifications.
 - 1. Provide shielded conductors and cable as required by the manufacturer or as required to provide for interference-free signals.
 - 2. Color coding shall be accomplished by using solidly colored insulation.
 - a) Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by NEC.
- C. Increase conductor sizes on cables as required to be consistent with circuit current ratings, length of wire runs, and manufacturers' recommendations.
 - 1. Alarm device field wiring shall be in accordance with the equipment manufacturer's specifications.
 - 2. Low voltage power circuits shall use conductors as required by the equipment manufacturer's specifications.
 - 3. Plenum rated cable shall be used as required by code.
- D. UTP Structured Cabling Systems for IP cameras and intercoms (including pulling, terminating, and testing) by Division 27 Telecommunications contractor.
 - 1. Intra-building data communications circuits shall utilize UTP cable as specified in Telecommunications specifications.

- E. Fiber Optic Structured Cabling Systems for IP cameras and intercoms (including pulling, terminating, and testing) by Division 27 Telecommunications contractor.
 - 1. Inter-building and building exterior data communications circuits shall utilize fiber optic cable as specified in Telecommunications specifications.
- F. Coaxial Cable
 - 1. RG-59U Coaxial Cable at 75 Ω with minimum center conductor of 20AWG solid Copper Center Conductor and dual braid shield shall be used for lengths up to 750'-0".
 - 2. RG-6/U Coaxial Cable at 75 Ω with minimum center conductor of 18AWG solid, bare copper and overall bare copper braided shield shall be used for cable runs more than 750'-0".
 - 3. All Coaxial Cable shall never be subjected to a bend less than a 0'-6" radius.
 - 4. Coaxial cable connectors shall consist of three-piece crimp BNC connectors.
 - 5. Coaxial cables with copper coated steel center conductors shall not be acceptable.
 - 6. All Coaxial Cable runs shall have a service loop of 20'-0" to compensate for any final field modification.
 - a) The cable shall be bundled and wrapped neatly in the above ceiling.
- G. Patch Cables
 - 1. Provide pre-manufactured patch cables (cable, connectors, boots, etc.) as required to connect security systems to voice and data communication outlets.
 - 2. Patch cables shall be certified for their specific use to meet or exceed applicable industry specifications.
 - 3. Provide cable lengths as necessary to neatly route cables through cable management systems and other cable organization systems.
 - 4. Provide connectors as required for proper termination.
 - a) Provide boots for connectors where applicable to prevent snagging.
- H. The minimum conductor sizes are for distances as per the manufacturer's specifications from security device to security panel.
 - 1. The contractor shall size the conductor accordingly for longer runs.
 - 2. Minimum Conductor and Cable Types and Sizes.
 - a) Alarm device field wiring shall be 18/20 AWG stranded copper conductors.
 - b) Low voltage power circuits will use 18 AWG stranded copper conductors.
 - 1) Increase conductor gauge consistent with circuit current requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All personnel working on this project shall be experienced, highly skilled installers with a minimum of three (3) years work on similar type projects.

- B. Changes in location of any work require the written approval of the Architect/Owner prior to initiation.
- C. Changes in indicated sizes shall not be made without the written approval of the Owner/Architect.
- D. Install all equipment in accordance with manufacturer's recommendations.
- E. All systems shall be designed and installed to provide 24 hour a day, 7 days a week operation.
- F. Primary pathways
 - 1. All security cabling run from rack/enclosure head-end equipment to security devices shall follow primary telecom routing pathways.
 - 2. Security wire non-UTP cabling shall be kept separated from the data cabling
 - 3. Security wire non-UTP cabling shall be routed in bridle rings secured to the outside of the telecom tray where applicable.
 - a) Arlington loops or J hooks shall be used where telecom pathways are not present
 - 4. Provide all necessary anchoring devices and supports.
 - a) Use structural supports suitable for equipment, or as indicated.
 - b) Check loading and dimensions of equipment with shop drawings.
 - c) Do not cut or weld to, building structural members.
- G. Secondary pathways
 - 1. Arlington loops or J hooks shall be used for secondary pathways
 - 2. Security wire non-UTP cabling shall be kept separated from the data cabling
 - 3. Provide all necessary anchoring devices and supports.
 - a) Use structural supports suitable for equipment, or as indicated.
 - b) Check loading and dimensions of equipment with shop drawings.
 - c) Do not cut or weld to, building structural members.
- H. Conduits (By Div 26)
 - a) All conduits shall be EMT unless specifically otherwise indicated.
- I. Coordinate extension and connection to commercial, emergency/UPS power circuits provided by Division 26.
 - 1. Make power connections in accordance with Division 26.
- J. Shielded and/or screened cables shall be grounded per the hardware manufacturer's instruction.
 - 1. Single point shield grounds shall be grounded at the field panel feeding the device or sub panel and insulated from ground at the termination end of the cable.
- K. All installation of security systems shall be complete at least thirty calendar days prior to occupancy.

3.2 RACK AND CABINET INSTALLATION

- A. Rack/cabinet installation by Telecommunications contractor.
- B. After racks are installed, install all required components to support rack mounted security equipment.
 - 1. Extend UPS/emergency power to rack mounted equipment as required.
- C. Install all conduits, back boxes, wire and cable management as required for interconnection of security equipment, data gathering panels, power supply enclosures, and distribution panels in the Security room.
- D. Extend commercial/emergency/UPS power circuits as required to security components as required.
- E. Neatly lace and dress all cables in each rack.
 - 1. All wiring and cable shall be properly supported.
 - 2. Utilize suitable cable management devices, no tie-wraps for UTP structured cabling allowed.

3.3 GROUNDING AND BONDING

- A. Equipment Cabinets and Racks
 - 1. To provide electrical continuity between rack elements, paint-piercing grounding washers shall be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
 - 2. A horizontal busbar shall be installed at the top and back of each rack for floor fed cabinets/racks.
 - 3. A vertical busbar shall be installed to the rear of the right-hand side rail with thread-forming screws to ensure metal-to-metal contact.
 - 4. Each rack shall be provided with a minimum # 6 AWG insulated ground wire.
 - 5. Do not bond racks serially (loop from rack to rack).
 - 6. Each rack bay against a wall shall be bottom/side ground feeds from the wall.
 - a) Wall ground feeds/raceways to racks shall not be exposed on the walls.
 - b) Exception
 - 1) Some rack bays will require the ground to be fed from the ceiling raceway. Refer to drawings for details.
 - 7. The Contractor shall provide a ground strap for each equipment rack and bond to the nearest Telecommunications Bonding Backbone (TBB) connection, Furnish all required bonding materials and hardware manufactured for this purpose.
 - a) Follow NEC bonding procedures/specifications.
 - 8. All ground raceways within each rack shall be an insulated metallic flex type raceway and shall not interfere with equipment mounting frames or equipment mounting brackets.
 - 9. Each ground feed shall provide proper installation allowances and penetration depths to provide conversion fittings from solid metallic to insulated metallic flex conduit raceways.

10. To bond each rack to ground, burnish clean a one square inch area, drill, tap, apply an adequate amount of antioxidant joint compound mixed for the metal surface types affected, and bolt connectorized conductor to burnished and compounded area.

- a) Ensure proper conductivity.

B. Cable Runway, Cable Raceway and Support System Grounding

1. The Contractor shall provide communications cable tray and cable runway systems with a communications isolated ground from the TBB.
2. All cable tray needs to be electrically continuous per NEC 250.96.
 - a) Metal raceways, wire-mesh cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as an alternate grounding path, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them.
 - b) Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces, and be connected by means of fittings designed so as to make good bonding points.
3. The Contractor shall provide and install #6 AWG insulated ground wire to bond one end of each cable tray/runway system to the #2/0 TBB.
4. For electrically non-continuous conduits that contain only grounding conductor, the Contractor shall bond the conduit and conductor together at both ends to ground to nearest TGB with grounding bushings or ground clamps.

3.4 Labeling

- A. Provide labeling for all security equipment components using waterproof, self-adhesive computer printed labels.
 1. Coordinate with Owner on numbering/labeling scheme.
- B. Provide labeling for all security cable/wiring using waterproof, self-adhesive computer printed labels.
 1. Coordinate with Owner on numbering/labeling scheme.
 2. Label all cables/wiring on both ends.
 3. At multi conductor cable terminations label each conductor.
 4. At a minimum, each cable/wire label shall designate:
 - a) Origination Point
 - b) Alarm point description
 - c) Opening description (if applicable)
- C. Provide a complete cable/wire identification plan/list with project completion submittal.
- D. Conduit and junction box exteriors may be identified with unique color paint, but shall not be identified with written words that easily identify the function of the conduit and boxes.

3.5 POWER REQUIREMENTS

- A. 120 VAC power dedicated to security will be provided. (By Electrical Contractor)
- B. Back-up power for all equipment and devices shall be for at least 4 hours unless otherwise specified.
 - 1. When generator backup power is available, provide a UPS, rated to maintain the load for a minimum of 15 minutes for all 120VAC equipment.
- C. Rack-mounted Uninterruptible Power Supply (UPS)
 - 1. Provide a UPS to support 120% of the required load to allow for future load expansion and age related deterioration of the battery performance.
 - 2. The UPS interface port shall have an RS-232 communications port and a 10 Base-T Ethernet for LAN management.
 - a) Provide the necessary data connection, hardware and software to remotely monitor the UPS
 - b) Provide user configurable computer operating system shutdown capability
 - 3. The control panel shall have a LED status display for load and battery bar graphs in addition to replace battery and overload indicators.
 - a) Rack-mounted surge suppression shall be vertically mounted and made for this orientation.
- D. All electronic locks shall be 12/24VDC (By Division 08)
- E. Connect to AC power and provide UL listed power supplies and transformers to distribute low voltage power to the system components as required.
 - 1. Provide uninterrupted battery backup power for the duration required above.
- F. All equipment connected to AC circuits shall be protected from power surges.
 - 1. The devices shall be installed and grounded per manufacturer instructions.
 - 2. Equipment protection shall meet requirements of ANSI C62.41.
 - 3. Fuses shall not be used for surge protection.
- G. All non-fiber optic data circuits that serve devices exterior to the buildings will be protected by surge protectors at the device and the termination.
 - 1. The devices shall be installed and grounded per manufacturer instructions.
 - 2. Equipment protection shall meet requirements of ANSI C62.41.
 - 3. Fuses shall not be used for surge protection.

3.6 Testing

- A. Ensure that all provisions and requirements of this specification are met.
 - 1. Verify through inspections, demonstrations and tests.

- B. Perform required tests to demonstrate workmanship, operation, and performance.
 - 1. Conduct tests with Architect/Owner and if required, inspectors of agencies having jurisdiction present.
 - 2. Arrange test dates in advance and give all parties a minimum of 48 hours notice.
- C. Repair or replace equipment or systems found defective or inoperative and re-test until 100% satisfactory results are obtained.
- D. Verification inspections will be made of all equipment components and installations for proper functioning of locking hardware and lock controls, mounting/placement of sensors, and cameras, etc. to guarantee requirements of the Contract Documents are complied with.
 - 1. The Owner's quality control representative shall have the opportunity to witness all inspections, or to conduct installation inspections of his own.

3.7 Functional Performance Test

- A. The Functional Performance Test (FPT) will be conducted at the end of the project and prior to system acceptance by the Owner.
 - 1. The security integrator will provide all necessary staff and communications needed to fully test all functions of the system.
 - 2. The contractor will submit for approval by the Architect and Owner, a comprehensive test plan that will include testing of every function on every door and security device thirty (30) days prior to the scheduled start of the test.
 - 3. The system will not be considered for acceptance prior to the successful completion of the FPT and completion of punch list items.
- B. Pre-Testing
 - 1. Following installation and prior to the FPT, the security integrator shall individually test each component and field device and verify the proper functioning of each component within a particular sub-system.
 - a) The contractor shall also test each sub-system until all detection zones, alarm assessment components, alarm reporting, surveillance and display components; along with access control functions have been verified.
 - b) Prior to the FPT all deficiencies must be corrected.
 - c) After sub-system verification is complete, test the entire system to assure that all elements and subsystems are compatible and function properly as a complete system.
- C. Upon completion of the outlined tasks and tests the security integrator shall schedule the FPT with the Architect and Owner.
 - 1. The security contractor must demonstrate that the security system components and sub-systems operate together as a system and meet specification requirements in the "As-Installed" operating environment.
 - 2. On conclusion of the FPT the test report document will be submitted to the architect for approval.
 - 3. The FPT will be observed by the architect's and Owner's representatives.

4. The FPT may be stopped at any time by these representatives if they believe the failure rate is too high or the system is not performing to contract document requirements.
5. The FPT will only resume when all deficiencies have been corrected.
6. Retesting will be required of all failed tests.

3.8 System Operational Test

- A. Upon completion of the FPT, conduct a formal test to be known as the System Operational Test (SOT), in which all components and sub-systems of the security system are demonstrated to operate error and failure free together as a system.
 1. This test is to be performed over a continuous seventy-two (72) hour period.
 2. A formal test plan and test procedures shall be prepared by the security subcontractor and submitted to the Owner/Architect for approval.
 3. The Security integrator must demonstrate that the system components and sub-systems meet specification requirements in the "As-Installed" operating environment and operate error and failure free for the duration of the test.
 4. If a system failure does occur, the failure must be documented and repaired, after which the seventy-two hour SOT period will restart.
- B. In the event that the Owner, Architect, or Contractor are required to witness a retest at a later date because the Security integrator is not properly prepared to conduct the acceptance tests or because the systems being tested have failed such tests, which shall be solely determined by the Architect or Owner witnessing the tests, the cost of witnessing additional tests shall be borne exclusively by the Security integrator.
 1. Costs are to be based on time and materials at the established rates of the Architect or Owner.

END OF SECTION 280000

SECTION 280500

COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. The requirements contained in this Section apply to all Section of this Division.
- B. Section Includes:
 - 1. Common terminology and requirements used throughout this Division.
 - 2. Requirements for Manufacturer Seismic Certification.
 - 3. Requirements for Manufacturer Special Seismic Certification.
 - 4. Electronic safety and security equipment coordination and installation.
 - 5. Sleeves for raceways and cables.
 - 6. Sleeve seals.
 - 7. Grout.
 - 8. Common electronic safety and security installation requirements.

1.2 DEFINITIONS

- A. AHJ: Authorities Having Jurisdiction.
- B. Bound Material: Bound refers to materials permanently bound, as by stitching or glue, or materials securely fastened in their covers by multiple fasteners that penetrate all papers. Ring binders, spiral binders, brads and screw posts are acceptable fasteners. Loose papers clipped together or stapled at one corner are not acceptable.
- C. Business Day: Where this Section and other Sections of this Division use the term "Business Day" it shall mean Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.
- D. EPDM: Ethylene-propylene-diene terpolymer rubber.
- E. FMS: Facility management system.
- F. NBR: Acrylonitrile-butadiene rubber.
- G. Seismic Certification: Seismic certification refers to a manufacturer's certification for architectural, mechanical, and electrical components, supports, and attachments pursuant to ASCE/SEI 7-05 Section 13.2.1.2.
- H. Seismic Qualification: Same as Special Seismic Certification
- I. Special Seismic Certification: Seismic certification of mechanical and electrical equipment based on ASCE/SEI 7-05 Section 13.2.2. Special Seismic Certification is required for active mechanical and electrical equipment that must remain operable following the design earthquake.

1.3 PERFORMANCE REQUIREMENTS

- A. The Drawings diagrammatically show the sizes and locations of various equipment and devices, and the sizes of the major interconnecting wires, without showing exact details as to elevations, offsets, wiring and other installation requirements. Carefully layout the Work at the site to conform to the architectural and structural conditions, to avoid obstructions and to permit proper grading of pipe associated with other portions of the Work. In cooperation with other trades, determine the exact location of equipment and devices and connections thereto by reference to the submittals and rough-in drawings, and by measurements at the site. Make minor relocations necessitated by the conditions at the site, or directed by the Owner, without additional cost to the Owner.

1.4 ACTION SUBMITTALS

- A. Common Requirements for Product Data: Where this Section and other Sections of this Division require Product Data to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
 - 1. Submit hardcopy of Product Data in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of product data submittals shall be bound materials as defined above. Separate products under distinct subheadings that correspond to paragraphs in specification text. Divide sections in binder with labeled divider tabs.
 - 2. In addition to hardcopies required by Division 01, submit one copy of product data in electronic format. All files shall be in Portable Document Format (.pdf).
 - 3. Product Data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.
- B. Product Data: Submit product data for each of the following.
 - 1. Sleeves.
 - 2. Sleeve seals.
 - 3. Grout.
- C. Common Requirements for Shop Drawings: Where this Section and other Sections of this Division require Shop Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures". In addition to the requirements of Division 01 comply with the following:
 - 1. Prepare Shop Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®.
 - 2. Submit hardcopy of Shop Drawings in the quantity as required under Division 01 Section "Submittal Procedures". Hardcopies of Shop Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 - 3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
 - 4. Shop Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.

1.5 INFORMATIONAL SUBMITTALS

- A. Common Requirements for Coordination Drawings: Where this Section and other Sections of this Division require Coordination Drawings to be submitted, meet the requirements defined in Division 01 Section "Submittal Procedures" and Division 01 Section "Project

Management and Coordination". In addition to the requirements of Division 01 comply with the following:

1. Prepare Coordination Drawings using computerized drafting software compatible with AutoDesk's AutoCAD®. Drawings files must be composite with multiple distinctive layers for each of the various trades.
 2. Submit hardcopy of Coordination Drawings in the quantity as required under Division 01. Hardcopies of Coordination Drawings shall have each sheet clearly labeled with a unique sheet identification number.
 3. In addition to hardcopies required by Division 01, submit one copy of Shop Drawings in electronic format. Files shall include both AutoCAD® compatible source files and files printed to Portable Document Format (.pdf).
 4. Coordination Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
- B. Coordination Drawings: Floor plans showing dimensioned layout for the following:
1. Penetration and Structural Opening: Floor plans showing sleeves and formed structural penetrations. Show sleeve and formed penetration layouts and relationships between structural components and other adjacent building elements, including but not limited to pre-tensioning and post-tensioning members where used.
 2. Reflected Ceiling Plans: ceiling plans, sections, and other necessary details showing dimensioned layouts for equipment located in or on the ceiling plane. Base dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the following items coordinated with each other, based on input from installers of the items involved:
 - a. Suspended ceiling components.
 - b. Structural members to which suspension systems for luminaires will be attached.
 - c. Perimeter moldings, decorative ceiling elements, and Architectural features.
 - d. Luminaires.
 - e. HVAC Diffusers, Registers and Grilles.
 - f. Speakers.
 - g. Sprinklers.
 - h. Fire Alarm initiating devices, including but not limited to the following:
 - 1) Smoke detectors.
 - 2) Heat detectors.
 - i. Fire Alarm notification appliances.
 - j. Occupancy sensors.
 - k. Access panels.
 - l. Security cameras and occupancy detectors.
 - m. Wireless Access Points.
 3. Equipment Layouts: Floor plans, elevations, and other necessary details showing dimensioned layouts for spaces containing safety and security equipment. Base equipment dimensions on exact dimensioned data obtained from product submittals for products to be included in the Work. Differentiate between field measurements and assumed dimensions. Include the following items coordinated with each other, based on input from installers of the items involved:
 - a. Equipment layout and relationships between components and adjacent structural and mechanical elements.
 - b. Indication of required working clearances and required area above and around electrical equipment where pipes and ducts are prohibited.
 - c. Location of Conduit entry into equipment.
 - d. Location of luminaires, sprinkler piping and heads, ducts, and diffusers.
 - e. Equipment support locations, type of support, and weight on each support.
 - f. Location of structural supports for structure-supported raceways.

- g. For floor mounted equipment: concrete base dimension, outline of equipment, and required clearances.
 - h. Location of structural supports for seismic bracing.
- C. Common Requirements For Qualification Data:
- 1. Professional Engineer Qualifications: Where this Section and other Sections of this Division require a Professional Engineer to be responsible for Delegated Design requirements; Submit Qualification data for Professional Engineer including, but not limited to, proof of registration in the Project location.
 - 2. Manufacturer Seismic Qualification Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems" Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 1) [The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."]
 - 2) [The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."]
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 3. Manufacturer Special Seismic Certification: Where this Section and other Sections of this Division require products to meet seismic requirements; Submit certification that equipment, devices, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" Include the following:
 - a. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

- A. Common Requirements for Material Quality: Materials, equipment and devices shall be new and of the quality specified, and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment or devices identical with those damaged, unless approved otherwise by the Owner in writing.
- B. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, and the Contract Documents, the most stringent shall govern. Perform the following:

1. Promptly notify the Architect in writing of any such difference.
 2. Obtain approval from Architect before proceeding with the Work.
 3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.
- C. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:
1. Promptly notify the Architect in writing of any such difference.
 2. Obtain approval from Architect before proceeding with the Work.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
1. Wherever a UL standard has been established for a particular type of material, equipment or device, each item of such material, equipment or device provided shall meet the requirements of the UL standard.

1.7 PRODUCT SUBSTITUTIONS

- A. Comply with provisions of Division 01 Section "Product ~~[Requirements]~~[Substitution Procedures]".
1. If item of equipment or device offered as Substitution differs in dimension or configuration from that indicated in the Contract Documents, provide, as part of the substitution submittal, a drawing that shows that the equipment or devices proposed for Substitution can be installed in the space available without interfering with other trades or with access requirements for operations and maintenance in the completed project. Drawings shall be of appropriate scale but shall not be smaller than a scale of 1/4-inch equals one foot.
 2. Where substitute equipment or devices requires different arrangement or connections from that indicated in the Contract Documents, install the equipment or devices to operate properly and in accordance with the requirements of the Contract Documents. Make incidental changes necessary in piping, ductwork or wiring which results from the inclusion of the substitute equipment or device without any additional cost to the Owner. Pay all additional costs incurred by other trades in connection with changes required by the inclusion of the substituted equipment or device in the Work.

1.8 PROJECT CONDITIONS

- A. [Interruption of Existing Fire-Alarm [and Security] Service: Do not interrupt fire-alarm [or security] service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire alarm service or fire watch according to requirements of local fire marshal:
1. Notify [Architect] [Construction Manager] [and] [Owner] no fewer than [five business] <Insert number> days in advance of proposed interruption of Fire-Alarm [or Security] service.
 2. Do not proceed with interruption of Fire-Alarm [or Security] service without [Architect's] [Construction Manager's] [and] [Owner's] written permission.]

1.9 COORDINATION

- A. In describing various materials, equipment and devices, in general each item may be described singularly, even though there may be a multiplicity of identical items. Also,

where the description is general in nature, the exact sizes, duties, space arrangements, and other requirements must be obtained by reference to other portions of Contract Documents.

- B. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer. Verify that all materials, equipment and devices proposed for use on this Project are within the constraints of the allocated space.
- C. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- D. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- E. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- F. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
- c. Metraflex Co.
- d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
- 3. Pressure Plates: Carbon steel. Include two for each sealing element.
- 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

- A. Comply with NECA 1 - Standard Practices for Good Workmanship in Electrical Construction, as published by the National Electrical Contractors Association.
- B. Comply with NECA 305 - Standard for Fire Alarm System Job Practices, as published by the National Electrical Contractors Association.
- C. Comply with NFPA 731 - Standard for the Installation of Electronic Premises Security Systems.
- D. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless otherwise indicated.
- E. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- F. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a manner as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- G. Right of Way: Give to piping systems installed at a required slope.
- H. Access Panels: Provide wall and ceiling access panels for unrestricted access to all concealed fire-alarm [and security] equipment items and devices installed behind furrings, chases or non-removable suspended ceilings. Access Panel materials and installation requirements are specified in Division 08 Section "Access Doors and Frames."
- I. Installation Inspections and Certifications
 - 1. Obtain timely inspections of the installation by Authorities Having Jurisdiction. Remedy any deficiencies to the satisfaction of the inspecting official.
 - 2. Upon final completion of the Work, obtain certificates of acceptance from the Authorities Having Jurisdiction. Deliver the certificates to the Owner.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves where cable or conduit penetrations occur. Install sleeves during erection of slabs and walls.
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Exception: Slab-on-grade construction shall not require sleeves or curbed formed openings when conduits or pipes that penetrate the slab-on-grade are installed and properly supported prior to the pouring of the slab.
- C. Masonry Walls: Install sleeves where cable or conduit penetrations occur. Install sleeves during erection of walls.
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- F. Non Fire-Rated Assemblies: Install sleeves where cable penetrations occur. Install sleeves during erection of walls.
 - 1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors a minimum of 2 inches above finished floor level.
- I. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless otherwise indicated **or unless seismic criteria requires different clearance**.
- J. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
 - 2. Apply approved joint compound for gypsum board assemblies where masonry or concrete wall is faced on interior side with gypsum board.
- K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

- M. Roof-Penetration Sleeves: Seal penetration of individual conduits and cables with flashing units applied in coordination with roofing work. Provide flashing unit as specified in Division 07 Section "Sheet Metal Flashing and Trim".
- N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 SEALANT

- A. Apply sealant to penetrations of all floor and wall assemblies to maintain pressure differentials required by for all pressure sensitive rooms. Sealant materials and installation requirements are specified in Division 07 Section "Joint Sealants" and Division 09 Section "Gypsum Board Assemblies."

3.5 FIELD QUALITY CONTROL

- A. Conduct tests as part of the Work of this Division. Include the services of qualified personnel as well as all equipment, apparatus, and services required.
- B. Conduct tests under conditions free from short circuits and from grounds.
- C. Prior to execution of testing, notify Architect of proposed test procedures and forms.
- D. Testing requirements are listed under individual sections of this Division. Sections requiring testing include, but are not limited to the following:
 - 1. NFPA 72 acceptance tests and startup for fire alarm system, in accordance with Division 28 Section "Fire Detection and Alarm."

3.6 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
- B. Apply putty pads to boxes located in fire-rated wall assemblies in which a horizontal distance of greater than 24" between boxes is not maintained. Putty pad materials and installation requirements are specified in Division 09 Section "Gypsum Board Assemblies."

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SECTION 281000

ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

PART 1 - GENERAL

1.1 SUMMARY/OVERVIEW

- A. This section provides specifications for the installation of Electronic Access Control (AC), Intrusion Detection (ID), and related components.
- B. Related Sections
 - 1. Section 087100 Door hardware
 - 2. Section 260000 Electrical (including related sub-sections)
 - 3. Section 270000 Communications (including related sub-sections)
 - 4. Section 280000 Electronic Security
 - 5. Section 282300 Video Surveillance
 - 6. Section 282600 Emergency Intercommunications and Duress
 - 7. Section 283100 Fire Alarm and Smoke Detection

1.2 REFERENCES

- A. See Section 280000 Electronic Security.

1.3 SYSTEM COORDINATION

- A. The Security Integrator shall completely coordinate all relevant work of other trades/systems including, but not limited to:
 - 1. Door hardware
 - 2. Fire Alarm System
 - 3. Elevator Control System
 - 4. Electrical Systems(s)
 - 5. Telecommunications System(s)
- B. Electric Locking Mechanisms
 - 1. The security integrator and door hardware contractor shall coordinate all door hardware, door and door frame design.
 - 2. The security contractor shall verify all specified door hardware is appropriate for the security application and verify the sequence of operations for each access controlled opening.
- C. Elevator Control System
 - 1. The security integrator shall verify the elevator security requirements and coordinate with the elevator installer to ensure the appropriate system interfaces are in place.

D. Fire Alarm and Life Safety

1. The security integrator shall coordinate the access control system design with the life safety consultant to insure compliance with applicable codes and requirements.
2. This includes, but is not limited to:
 - a) Fire alarm interface
 - b) Fail safe/fail secure locking mechanisms
 - c) Delayed egress

1.4 GENERAL SYSTEM DESCRIPTION

A. General Requirements

1. Furnish all labor, materials, tools, equipment, and services for a complete security system as indicated and in accordance with provisions of the contract documents.
2. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
3. Comply with the provisions of Division 1 for General Requirements.
 - a) In the event of a conflict between the provisions of this Section and Division 1, the more stringent provisions shall apply.
4. All system devices and components included shall be compatible.

B. The project shall be equipped with a **CBORD** Access Control / Services system that is an extension of an existing system maintained by Midwestern State University Card Services at the Clark Student Center.

1. All work required within the project for extension of the AC/ID system to the existing system head end shall be furnished and installed by the project security contractor.

C. The AC/ID system will support the needs of the project in accordance with these specifications.

1. The AC/ID system shall have the capability for future expansion to support the security needs of the completed complex.

D. The AC/ID system shall be interfaced with the Fire Alarm system (by others) as required to comply with all building code requirements.

E. Emergency/UPS power will be utilized to power the AC/ID system's computer workstation (client) at the Security head end equipment location.

F. Emergency/APS power will be utilized to power the AC/ID system's Data Gathering Panels and control components as required throughout the facility.

1.5 ACCESS CONTROL SYSTEM

A. The AC system will consist of card readers, door position switches, and request-to-exit sensors operating in conjunction with associated electric door hardware.

1. Card readers and adjunct devices shall be provided as shown on the drawings.
 - a) Provide card readers, Data Gathering Panels <DGP>, and alarm input and output devices connected to the security management system via Local Area Network (LAN).
 - b) The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided device, the location to be installed, and the port configuration needed for communication.
 - c) Furnish all labor, materials, tools, equipment, and services for a complete system as indicated and in accordance with provisions of the contract documents.
 - d) Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
- B. Card readers will work such that upon presentation of a valid AC card, the unique card data shall be transmitted to an associated control panel where the data is compared to an authorized user database and access is approved or rejected accordingly.
 1. A valid authorization will activate operation of the electric lock and shunt the door position switch. The alarm shunt will not affect supervision of the detection circuit.
 2. Coordinate with owner on card format and other pertinent details.
- C. Card readers shall support Magnetic Stripe technology.
- D. Door position switches at card reader controlled location serve to indicate the open/closed status of the associated door and shall establish the basis for reporting a door-propped or unauthorized entry condition.
 1. Provide door position switches as indicated on drawings.
 2. Security contractor is responsible for coordinating the contact configuration (SPDT) (DPDT) and rating for door position switches, and for connection of switches with the AC.
- E. Electrified door hardware for card reader controlled doors will include electrified locksets, electric exit devices, and electric power transfer as shown on the drawings.
 1. All electrified door hardware shall be provided under the work of Division 08 unless otherwise noted.
 2. Security subcontractor shall provide all security cables and, low voltage power supplies for operation of electrified door hardware associated with card reader controlled doors.
- F. Request-to-exit (REX) devices at designated card reader controlled doors shall cause the associated door position switches to be shunted.
 1. The alarm shunt shall not affect the supervision of the alarm detection circuit.
 2. Electrified Lockset shall have an integral REX switch.
 3. Electrified Exit devices shall have an integral REX switch.
 4. Magnetic Locks shall have a Passive InfraRed (PIR) motion sensor REX device.
 - a) Wire the PIR to the Door REX Input. The configuration on this motion shall be non-resettable and activate for only 2 seconds.
 - b) A second set of output contacts for the REX motion sensor shall be wired in series with the power to the lock, disconnecting power to the lock when motion is sensed.
 - c) The PIR REX shall be mounted and the sensor positioned to avoid detection more than three feet from the door and at the door bottom sweep.

- 1) Deter under door spoofing attacks by pointing the sensor away from the door threshold. Position the sensor to detect motion at the door handle or door push plate.
 - d) Connect to REX switch in exit device (by Division 8).
 - 1) Coordinate with Division 8 to ensure proper REX switch configuration
 - 2) Wire the REX switch as described for the above motion sensor to disconnect power to the lock and activate the REX input on the DGP.
 - e) Doors with out exit devices, a UL listed double pole pushbutton exit switch shall be provided as a redundant REX device.
 - 1) It shall be wired as described for the above motion sensor to disconnect power to the lock and activate the REX input on the DGP.
 - 2) Locate within 6'-0" of the door push-plate/handle.
- G. Card Reader Controlled Automatic Sliding 'Storefront' Doors
1. Interface the Card Reader Control Point to the Automatic Sliding 'Storefront' Doors to activate/deactivate locking solenoid and to enable and disable the outside motion detector.
 2. The egress motion detector shall always unlock and open the sliding door and send a signal to the system to shunt the notification of an intrusion alarm.
- H. Card Reader Controlled Elevators
1. The system shall provide for card reader control of Elevator Floor select buttons.
 2. When the card reader is in Card Access mode, a properly programmed card shall enable the floor select buttons allowing the user to select the appropriate floor select button for access.
 3. The contractor shall provide a relay for every floor in every cab.
 - a) Example: 3 floors and 2 cabs = 6 relays.
 4. The system shall allow button selection for 5 seconds per valid card read.
 5. When the card reader is in free access, the floor select buttons shall operate normally.
- I. Remote Door Release Button
1. Designated doors equipped with electric locking devices that can be released from a remote location through the use of a door release push-button.
 - a) The momentary push-button shall be interfaced with the request-to-exit signal of the associated card reader to provide momentary release of lock and momentary door alarm shunt.
- J. Power over Ethernet (PoE) Electrified hardware with Card Reader
1. Electrified door hardware includes Card Reader, Door Position Switch, and Request to Exit (REX) all in device.

- a) The Security contractor shall be responsible for furnishing and installing conductors (harness) from UTP termination above door (By Div 27) to PoE lockset as per manufacturers requirements.
- b) The Security contractor shall ensure all PoE lock components are properly grounded as per manufacturers' requirements.
- c) The Security contractor shall be responsible for furnishing and installing the PoE lockset as per manufacturers' requirements and coordinating with Division 08 on PoE lock requirements including:
 - 1) Coordinate with Division 08 all door, bracket, and frame requirements.
 - 2) Coordinate with Owner all PoE switch gear and IP/TCP routing requirements.
 - 3) Provide any and all licensing requirements and integration programming with existing systems to allow for a fully functional controlled opening.

1.6 INTRUSION DETECTION SYSTEM

- A. A series of field installed alarm initiating devices shall be connected to the ID system so that status changes of the devices are transmitted to the security management system.
 - 1. Provide Data Gathering Panels <DGP>, alarm devices, and keypads to be connected to the security management system via Local Area Network (LAN).
 - 2. The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided device, the location to be installed, and the port configuration needed for communication.
- B. Wireless Alarm Receiver
 - 1. Provide wireless alarm receivers to receive wireless device alarms and transmit alarms to AC/ID system monitoring locations.
 - 2. Provide wireless survey to confirm coverage area and quantity of receivers, repeaters, and/or antennas required. Provide adequate quantity of receivers, repeaters, and/or antennas to provide reliable wireless communications with wireless alarm transmitters.
 - 3. Provide full integration of the wireless alarm receiver with the AC/ID system
 - 4. Provide dry contact alarm relay or high level interface to AC/ID alarm panel
 - 5. Provide individual alarm notification for fault, low battery, transmitter missing/out-of-range and all other transmitter/receiver failures.
 - 6. Provide alarm logging.
- C. Motion Detector
 - 1. Provide dual technology (microwave and infrared) to prevent false alarms.
 - a) Specific model depends on application and mounting requirements.
 - b) One motion detector per zone, do not wire in series.
- D. Glass Break Detector
 - 1. Contractor will need to provide compatible glass break tester for device being installed.
 - 2. One glass break detector per zone, do not wire in series.
- E. Tamper Switches

1. Typically closed tamper switches to monitor the secure status of all DGP's, power supplies, terminal cabinets, power distribution units, and other Security System cabinets and enclosures.
2. Fasten tamper switches within the cabinet to provide no access to the switch and fasteners when the cabinet is closed.
3. Provide independent monitoring of tamper conditions for each cabinet.

a) Include the number of tamper switches in the total alarm input figures.

- F. Provide ID keypads conveniently located near areas being protected so as to allow devices to arm and disarm.

1.7 SUBMITTALS

- A. Follow provisions of Section 280000 additional requirements.
- B. Field Test Reports
1. Upon completion and testing of the installed system, test reports shall be submitted in booklet form and electronic media showing all field tests performed on, and adjustments made to each/any component and all field tests performed to prove compliance with the specified performance criteria.
 2. Indicate and interpret test results in written form and verbally to owner/DataCom for compliance with performance requirements at a pre-scheduled meeting.
- C. Battery calculations to show the expected loads and backup duration for power supplies and UPS devices for all active AC/ID equipment.
- D. Security Contractor is responsible to prepare and submit as required to the Authority Having Jurisdiction (AHJ) any and all information to obtain an Electronic Locking Mechanisms permit.

1.8 QUALITY ASSURANCE

- A. Follow provisions of Section 280000.
- B. Spare Parts:
1. Provide spare components for every model and configuration of electronic components and devices used on the project as spare parts inventory.
 - a) The security integrator will turn over the new and unused components and devices to the owner at project closeout.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Follow provisions of Section 280000.

1.10 PROJECT/SITE CONDITIONS

- A. Follow provisions of Section 280000.

1.11 WARRANTY

- A. Follow provisions of Section 280000.
- B. All devices and components shall comply with applicable U.L. standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. AC System Platform Software
 - 1. CBORD (Existing)
- B. Access Control Data Gathering Panels <DGP>
 - 1. CBORD System compatible
- C. Card Readers <CR>
 - 1. MR5 CBORD reader
- D. Door position Switches <DP>
 - 1. Concealed Magnetic Door position Switch
 - a) Sentrol 1076D
 - b) Magnasphere MSS-19C/L / MSS-25C/L
 - c) Detection Systems, Inc
 - d) Owner Approved Equivalent
 - 2. Surface Mount Door and Hatch Position Switch
 - a) Sentrol 2500
 - b) Magnasphere MSS-3XXS
 - c) Owner Approved Equivalent
 - 3. Overhead Door position Switch
 - a) Sentrol 2200 (floor)
 - b) Sentrol 2300 (side)
 - c) Owner Approved Equivalent
- E. Electric Locking Mechanism Power Supply
 - 1. Altronix
 - 2. Alarm-Saf
 - 3. LifeSafety Power
 - 4. Owner Approved Equivalent
- F. Uninterruptible Power Supply <UPS>

1. Eaton UPS
 - a) 5S series for workstations
 - b) 9170 for rack mounted equipment
 2. APC Smart-UPS Series
 - a) SMT series for workstations
 - b) Smart-UPS on-Line series for rack mounted equipment
 3. MinuteMan
 - a) Pro series for workstations
 - b) Enterprise Plus series for rack mounted equipment
 4. Owner Approved Equivalent
- G. Wire & Cable
1. Belden
 2. Windy City
 3. General Cable
 4. Owner Approved Equivalent
- H. Keypads
1. CBORD System compatible
 2. Owner Approved Equivalent
- I. Tamper Switches
1. Sentrol 3010
 2. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Power Supplies
1. Power supply requirements
 - a) A switch and on/off indicator within the power supply cabinet.
 - b) Four hours of sealed gel battery backup to provide continuous operation during power failure.
 - 1) Provide batteries as required to provide specified battery backup time for a fully loaded power supply, regardless of the connected load.
 - c) A battery charger to maintain the battery.
 - d) Low battery and power fail contacts to monitor the status of the input power and the battery.

- 1) Connect each power supply low battery and power fail alarm as a separate alarm input into DGP.
 - e) Key lockable wall mount metal enclosure with tamper switch.
 2. Additional DGP Power Supply Requirements
 - a) The DGP power supply provides power only to DGP's and shall not provide power for locks or any other low voltage device.
 3. Additional Electric Locking Mechanism Power Supply Requirements
 - a) Fail secure electric locking mechanisms shall remain locked during power failure and fire alarm conditions.
 - b) Connect fail safe locking devices in accordance with applicable life safety codes to unlock automatically under the following conditions:
 - 1) Loss of power to the power supply
 - 2) Failure of the power supply
 - 3) Fire alarm activation
 - c) Provide power distribution boards with independently fused output relays and fire alarm control panel interface.
 4. Additional Device Power Supply Requirements
 - a) Provide device power supplies for other security system devices requiring power (e.g. card readers, local alarms, motion sensors, etc.)
 - b) Provide power distribution boards with independently fused outputs.
- B. Video Surveillance System Integration
1. Automatic Video Call-up
 - a) All alarms shall call up all cameras in the area of alarm to the screen of the ACID alarm operator workstation to allow for operator assessment of the alarm.
 2. Pre and Post Alarm Video
 - a) The operator shall be able to view up to 10 seconds of video before the alarm and 30 seconds after the alarm for all cameras associated with the alarm.
 - b) This feature is to be integrated with the operator alarm notification to assist in alarm assessment.
 - c) This feature shall be displayed as an option on the alarm notification screen and will not require operator to make a manual video search.
 3. Recording
 - a) All cameras whose field of view that include images of the area affected by the alarm, shall be recorded when an alarm is detected for use in forensic analysis, including the pre and post alarm video.
 4. Duress and Emergency Intercommunications Integration

- a) Calls from emergency intercoms/phones with cameras shall provide the above video call-up and the pre and post alarm video capabilities.

C. Tamper Resistant Screws

- 1. Provide appropriate screw heads for each application (e.g. countersunk heads for recessed cover plate screws, flat head screws for standard junction box covers, etc.).
- 2. The security integrator shall provide Torx® tamper resistant screws for:
 - a) Junction boxes located above doors
 - b) Junction boxes located below ceiling height and/or within reach of hatch ladders
 - c) Security device cover plates
 - d) Surface mounted door position switches and armored cable

3.2 ENCLOSURE INSTALLATION

- A. Enclosures shall be lockable with a tamper switch and installed in a manner to be accessible with clearance to fully open enclosure door.
- B. All security panels shall be wired through a dedicated power supply with battery backup.
 - 1. Power to the data gathering panels is to be hardwired utilizing EMT or rigid conduit in accordance with the Electrical specifications.
 - 2. A circuit from the Fire Alarm panel must be installed to each lock power distribution panel.
- C. Enclosures shall be installed on designated wall fields in a neat and compact manner to allow for future growth.
- D. Enclosures shall be sized to allow for 20% growth in each panel.
- E. All panels and boards shall be installed in enclosure(s) suitable to their environment and have sufficient size and orientation to include all system components.
- F. Each panel shall be labeled accordance with Owner standards.

The label for each panel shall be posted on the exterior of the panel door.

- a) Each panel shall have a list of devices connected to it located on the inside cover.
- b) A detailed device layout drawing will be located on the inside of the panel door in an appropriate sleeve and keeper.

3.3 FURTHER REQUIREMENTS

- A. Refer to provisions of Section 280000.
- B. Furnish and coordinate installation of all special device back boxes and ACID field devices as shown on the security drawings and as specified in this section.
- C. The exact installation locations of all equipment shall be coordinated and verified with the Contractor prior to installation.

1. Subcontractor shall notify the Contractor if any location appears to be unsuitable.
- D. Provide low voltage power supplies for electric locking devices and ACID devices and components as shown on the security drawings and specified in this Section.
- E. Coordinate with the Telecommunications Subcontractor for data network connections, IP address requirements, and telephone circuits as required.
- F. Prepare all systems for user operation.
 1. The security system must be complete and ready to operate prior to Owner final acceptance of the system.
- G. Coordinate with the Owner for all system programming requirements.
- H. Perform database programming as required to support the card reader, alarm point, surveillance system integration, and control panel configuration as required.

END OF SECTION 281000

SECTION 282300
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY/OVERVIEW

- A. This section provides specifications for the installation of an IP based Video Surveillance System (VS) and related components.
- B. Related Sections
 - 1. Section 260000 Electrical (including related sub-sections)
 - 2. Section 270000 Communications (including related sub-sections)
 - 3. Section 280000 Electronic Security
 - 4. Section 281000 Electronic Access Control and Intrusion Detection
 - 5. Section 282600 Duress and Emergency Intercommunications and Duress

1.2 REFERENCES

- A. See Section 280000 Electronic Security.

1.3 SYSTEM DESCRIPTION

- A. The Health Science & Human Services Center will be equipped with a Video Management System (VMS) that is an extension of the existing **Avigilon** VMS maintained by Midwestern State University campus police department.
 - 1. The new Video Management System (VMS) shall facilitate interface with the existing security head end equipment.
 - 2. All work required to make available an extension to existing equipment shall be furnished and installed by the security subcontractor.
 - 3. The Local Area Network (LAN) shall be used to make available the viewing of live and recorded signals from the local PC based NVR to other locations.
- B. The security integrator shall furnish and install the surveillance system, consisting of camera assemblies, NVR, wiring & cabling, and low voltage camera power supplies.
 - 1. All active surveillance equipment and communication devices shall be on emergency/UPS power.
- C. Camera assemblies include camera, lens, housing, and mount. Provide and install wiring and low voltage power from the security wall field/rack to the camera locations.
 - 1. Scope of work shall be complete from point of origin (camera) to point of termination (security rack).

- D. Provide rack mount 1U monitor/keyboard/track ball drawer with 20" LCD monitor for display and programming, keyboard, track ball, and integrated four-port KVM switch.
 - 1. Provide additional KVM ports as required plus two spare ports if Work includes more than two NVRs.
- E. Coordinate all work that must be performed in security head end spaces with the General Contractor, the Electrical Contractor, and the Telecommunications contractor. (if applicable)
- F. Camera images shall support H.264 compression formats.
- G. The NVR shall not be loaded to exceed 50% of the camera and/or storage capacity to allow room for expansion.
- H. Camera lenses for fixed cameras shall be varifocal and sized to provide the owner approved field of view. The lens shall be IR corrected and have megapixel resolution.
- I. Surveillance camera audio functions shall not be installed and/or disabled unless specifically requested by Owner.

1.4 SUBMITTALS

- A. Follow provisions of Section 280000 for additional requirements.
- B. Project Data
 - 1. Provide a description of system operation indicating the purpose and capability of each device/component of the system with a functional diagram indicating all interfaces to other systems.
- C. Video Quality test reports shall be provided for all cameras to confirm an optimum high definition video signal.
- D. Shop drawings shall reflect all requirements associated with Owner provided or existing equipment and materials that will be used as part of this system.
- E. Video Storage calculations to show the system capacity can accommodate the specified video retention.
- F. Battery calculations to show the expected loads and backup duration for camera power supplies and UPS devices for all active surveillance equipment.
- G. System programming, camera titles, descriptions, camera images and database
 - 1. Camera titles and descriptions prior to system programming
 - 2. Programming/database prior to performance testing
 - 3. Provide a cross reference between specified camera numbers and programmed camera numbers
 - 4. Final programming, camera images and system documentation on electronic media to Owner
- H. Product Data

1. Manufacturer's technical data sheets and specifications

1.5 QUALITY ASSURANCE

- A. Follow provisions of Section 280000.
- B. Spare Parts:
 1. Provide spare components for every model and configuration of electronic components and devices used on the project as spare parts inventory.
 - a) The security integrator will turn over the new and unused components and devices to the owner at project closeout.

1.6 DELIVERY, STORAGE AND HANDLING

- A. See Section 280000.

1.7 PROJECT/SITE CONDITIONS

- A. See Section 280000.

1.8 WARRANTY

- A. See Section 280000.

PART 2 - PRODUCTS

2.1 CAMERA SPECIFICATIONS

- A. All cameras shall be a Dome Camera unless otherwise specified
 1. Compatible with the VMS
 2. Vandal resistant with polycarbonate dome
 3. Wide Dynamic Range Feature: All exterior cameras and interior cameras that have exterior lighting or headlights in their field of view shall have a Wide Dynamic Range feature to improve picture quality in situations with strong backlighting.
 4. Multi-stream so that recording and viewing can be at different frame rate and compression.
 5. Day-night Color/B&W camera with cut filter
 6. Exterior cameras:
 - a) Shall be outdoor rated
 - b) Include a heater to permit fog-free viewing in low temperatures
 - c) Fan to prevent overheating in high temperatures (as required)
- B. Interior Fixed Dome Cameras:

1. Shall be IP, PoE IEEE 802.3af
2. Day-night Color/B&W camera with cut filter
3. Smoked lower dome
4. Resolution shall be a minimum of 2MP (1080p) at 30 FPS
5. Vari-focal auto-iris fixed lens sized to provide the owner approved field of view
6. Shall have a minimum sensitivity of 0.05 Lux at:
 - a) 30 IRE
 - b) 75% reflectance
 - c) AGC off
 - d) 1.2 f-stop
 - e) Sense-Up off

C. Interior/Exterior Fixed Wide Angle Lens Cameras:

1. Resolution shall be a minimum of 5.0 MP at 30 FPS
2. Dome Camera is preferred over a Box Camera
3. Wide angle view cameras include views of 180°, 270°, and 360° (as indicated)
4. Auto-iris wide angle lens
 - a) Shall be Rectilinear Lens to minimize barrel distortion
 - b) C/CS mount removable lens
 - c) Wide horizontal field of view minimum of 90°
 - d) Size lens to provide the owner approved field of view
5. Size camera and lens for facial recognition at a minimum of 60 pixels per foot at the target location
6. Shall have a minimum sensitivity of 0.05 Lux at:
 - a) 30 IRE
 - b) 75% reflectance
 - c) AGC off
 - d) 1.2 f-stop
 - e) Sense-Up off

D. Exterior Fixed Dome Cameras:

1. Shall be IP, PoE IEEE 802.3af
2. Clear lower dome, unless otherwise specified
3. Resolution shall be a minimum of 2MP (1080p) at 30 FPS
4. Vari-focal auto-iris fixed lens sized to provide the owner approved field of view.
5. Shall include remote focus and zoom over the network
6. Shall have a minimum sensitivity of 0.05 Lux at:
 - a) 30 IRE
 - b) 75% reflectance
 - c) AGC off
 - d) 1.2 f-stop
 - e) Sense-Up off

E. Interior/Exterior Pan Tilt Zoom (PTZ) Dome Cameras:

1. Shall be IP
2. Clear lower dome
3. Resolution shall be a minimum of 1.3MP (720p) at 30 FPS

4. Auto-iris
5. Zoom - 18 x optical zoom lens and 12 x digital zoom.
6. Operator controlled panning speed shall be at least 300 degrees per second and 360 degree continuous pan rotation.
7. 50 presets minimum
8. Shall have a minimum sensitivity of 0.04 Lux at:
 - a) 30 IRE
 - b) 75% reflectance
 - c) AGC off
 - d) 1.2 f-stop
 - e) Sense-Up off

F. License Plate Cameras:

1. Shall be IP, PoE IEEE 802.3af or 802.3at
2. Include pole and wall mount accessories
3. Include infrared (IR) illuminator accessory
4. Include camera housing with sunshield, heater/blower to meet IP66, IP67 and NEMA 4
5. Include an SD card sized to allow for scheduled and event based storage of images
6. Camera resolution shall be a minimum of 2MP (1080p) at 30 FPS
7. Include IR corrected, varifocal CS-mount lens. Provide lens sized to provide the owner approved field of view. Size camera and lens to view a minimum of 60 pixels per foot at the target location
8. Camera shall have remote focus and zoom over the network
9. Camera shall have a minimum sensitivity of 0.22 lux (color) and 0.02 lux (B/W) at 50 IRE
10. Locate camera perpendicular to the viewing surface

2.2 NETWORK VIDEO RECORDER

A. The Network Video Recorder shall be compatible with the existing Avigilon video management system along with the following minimal requirements:

1. Hot swappable storage drives in a RAID 5 array
2. Dual hot swappable redundant power supplies
3. Support dual stream cameras
4. Include a dual Network Interface Card (NIC) that supports:
 - a) Full duplex
 - b) Fault tolerance
 - c) Link aggregation
 - d) Load Balancing
 - e) Traffic prioritization
 - f) Hot swap
5. Native support of H.264 compression that does not require the use of additional software or equipment
6. Provide a 20 inch 1080P service monitor and keyboard at each NVR equipment rack
7. Provide video storage capacity for 30 days using the following minimum criteria
 - a) All cameras using H.264 compression
 - b) Interior cameras: Use native camera resolution
 - c) Exterior cameras: Use native camera resolution
 - d) Wide angle lens cameras: Use native camera resolution

e) Motion triggered recording

- 1) Assume that motion will be detected 50% of the day
- 2) Motion detection will be configurable by camera and schedule to mitigate nuisance triggers
- 3) Record video at 12 FPS when motion is detected
- 4) Record video at 1 FPS when no motion is detected

B. Coordinate with owner on the number of user licenses required

C. Provide UPS for backup power to the NVR and peripheral equipment

1. Follow provisions of Section 28000 for UPS power requirements
2. Coordinate with Division 26 to provide a dedicated power circuit

2.3 PoE NETWORK SWITCH

A. Provide a fully configured rack mounted PoE Managed 10/100/1000Mbps Layer 3 Switch.

1. Coordinate switch make and model with Owner / Owner network representative prior to purchase to ensure compatibility with existing and non-surveillance related network appliances.
2. Coordinate with Owner / Owner network representative on video surveillance subnet assignment.
3. Switch port count shall allow for 10% growth.

2.4 SURVEILLANCE CAMERA ELEVATOR TRANSCEIVER

A. For each elevator cab equipped with a surveillance camera, provide transceivers at elevator machine room and at elevator cab for transmission of surveillance video signals over traveling cable.

B. Camera technology: IP, PoE IEEE 802.3af

C. Traveling cable: Coaxial, STP, UTP, provided by elevator contractor. Coordinate and confirm traveling cable specification and camera transceiver requirements with elevator contractor.

D. Power supply:

1. Elevator machine room: 120VAC 60Hz input voltage
2. Elevator cab: PoE over elevator traveling cable

2.5 ACCEPTABLE MANUFACTURERS

A. Video Management System (VMS) Platform Software

1. Avigilon (existing)

B. NVR Server: Compatible with VMS Requirements

1. NVR specification compliant hardware

C. Video Monitor:

1. LG
2. Optquest
3. Samsung
4. Viewsonic
5. Owner Approved Equivalent

D. Interior IP Camera Mini Dome

1. American Dynamics
2. Axis Communications
3. Bosch
4. FLIR Systems
5. Panasonic
6. Pelco
7. Samsung
8. Sony
9. Vicon
10. Owner Approved Equivalent

E. Exterior IP Camera Mini Dome

1. American Dynamics
2. Axis Communications
3. Bosch
4. FLIR Systems
5. Panasonic
6. Pelco
7. Samsung
8. Sony
9. Vicon
10. Owner Approved Equivalent

F. Exterior Color Camera PTZ Dome

1. American Dynamics
2. Axis Communications
3. Bosch
4. FLIR Systems
5. Pelco
6. Samsung
7. Sony
8. Vicon
9. Owner Approved Equivalent

G. Exterior Parapet/Roof Deck Camera Mount

1. Axis Communications
2. American Dynamics
3. Pelco
4. Owner Approved Equivalent

H. Wide Angle Megapixel Camera Lens

1. Computar
 2. Theia
 3. Owner Approved Equivalent
- I. Camera Power Supply
1. Altronix
 2. Alarm-Saf
 3. LifeSafety Power
 4. Owner Approved Equivalent
- J. Equipment Racks and Racks Components: (By Division 27)
1. Chatsworth Products (CPI)
 2. Ortronics
 3. Newton Instruments
 4. Owner Approved Equivalent
- K. Lockable Equipment Cabinet and Components: (By Division 27)
1. Chatsworth Products (CPI)
 2. Ortronics
 3. Newton Instruments
 4. Owner Approved Equivalent
- L. PoE Network Switch –Coordinate with Owner
1. Brocade
 2. Cisco
 3. Juniper
 4. Arista
 5. Owner Approved Equivalent
- M. Surveillance Camera Elevator Transceiver
1. Network Video Technologies
 2. Nitek International
 3. Axis Communications
 4. Owner Approved Equivalent
- N. Video Wire & Cable
1. Windy City
 2. General Cable
 3. Belden
 4. CommScope
 5. Owner Approved Equivalent
- O. Uninterruptible Power Supply (UPS)
1. Eaton UPS
 - a) 5S series for workstations
 - b) 9170 for rack mounted equipment

2. APC Smart-UPS Series
 - a) SMT series for workstations
 - b) Smart-UPS on-Line series for rack mounted equipment
3. MinuteMan
 - a) Pro series for workstations
 - b) Enterprise Plus series for rack mounted equipment
4. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 CONFIGURATION

A. Video Cameras

1. Provide day/night cameras in exterior locations
2. Lenses shall be field tested with Owner present to verify clear, crisp images and desired field of view
 - a) Substitute camera lenses as necessary to obtain required field of view at no additional cost
 - b) Provide spot filters for exterior lenses as required to reduce picture washout caused by sunlight

B. IP PoE Cameras

1. The security integrator shall coordinate network and IP address requirements with Owner to identify the Media Access Control (MAC) address (Layer 2) of each provided camera, the location to be installed, and the port configuration needed for communication.
2. Make all necessary adjustments to camera lenses to obtain clear, crisp images and desired field of view to the Owners satisfaction.
 - a) Substitute camera lenses as necessary to obtain required field of view at no additional cost.
 - 1) Adjust all cameras to produce high-definition images with no blooming, streaking or noticeable lag.
 - 2) Provide and install in-line PoE injectors as required when non PoE network switches are used or when manufacturer specified power is not available to the camera.
 - 3) All camera power shall comply with the specified power requirements.

3.2 POWER REQUIREMENTS

A. Provide uninterruptible power supplies for all active surveillance equipment

1. Rack mounted components, including all active network communication hardware, shall be on an Uninterruptible Power Supply <UPS> system.

2. Refer to Section 280000 for UPS and power requirements
3. Camera power supplies shall be on an Auxiliary Power Supply <APS>, system as required, with a battery backup.

- a) The Auxiliary power supply shall be furnished with a power distribution panel with each camera individually fused or protected with an over-current protector.

B. Power supplies shall provide:

1. 120 VAC input and output voltage as required
 2. UL Listed
 3. Power fail contacts to monitor the status of the input power
- a) Connect each power supply power fail alarm as a separate alarm input into AC/ID system
4. Key lockable wall mount metal enclosure with tamper switch
 5. Independently fused outputs

3.3 INSTALLATION

A. Refer to provisions of Section 280000

B. All surveillance system devices and components shall be compatible.

C. Camera Housings and Mounts

1. Cameras shall include housings and mounts as indicated in the Drawings.
- a) Provide the smallest available housing for each camera application.
- 1) Integrated miniature dome cameras are preferred
2. Wiring to cameras shall pass from the back-box through the mount and into the housing. Exposed wiring or conduit shall not be acceptable.
 3. Provide sun shields for camera housings in outdoor locations exposed directly to sunlight.
 4. Provide surge protection for power and copper video cables for exterior cameras at the camera and at the point of termination (security rack).
 5. Field verify the exact camera location, position, and mounting prior to installation.
 6. Roof mounted cameras shall use roof deck brackets.

D. Video Management Control System

1. System platform software shall be 'open architecture' allowing for compatibility and integration with other building automated systems.
2. The system shall allow for secure remote viewing of live and recorded video as required.

E. Provide labeling suitable to Owner for all major equipment components. Coordinate with Owner on numbering scheme to match existing. Major equipment components:

1. Video monitors, IP camera Patch Panels, PoE Switches (or mid-span units), Network Video Recorders (NVR), and fiber mux units (if required).

- F. Coordinate with Telecommunication subcontractor for network and patch panel provisions for security connections in the IT room. (If applicable)
- G. Coordinate with Owner for all system programming and database requirements.
 - 1. Provide all programming, setup, camera and device titling and data entry
 - 2. Camera and device title and descriptions shall be consistent for all components
- H. Install all Point-to-Point wiring with appropriate terminal connections for every wire and component termination so that all connections are mechanically and electrically secure.
- I. Install field wiring in continuous lengths, without splices.
- J. Verify upon job completion that all wiring and terminations are clearly labeled to identify the wire and terminal.
- K. Testing of the surveillance system includes checkout of installed cameras back to the Security head end equipment to confirm proper operation of camera assemblies. Security integrator shall provide all necessary test equipment to fully demonstrate proper performance of field devices. Copies of test results shall be included in the project completion submittals given to the Owner.

END OF SECTION 282300

SECTION 282600

EMERGENCY INTERCOMMUNICATIONS AND DURESS

PART 1 - GENERAL

1.1 SUMMARY/OVERVIEW

- A. This section provides specifications for the installation of Emergency Intercommunications and Duress (EID) system and related components.
 - 1. Emergency Phones
 - 2. Intercoms
 - 3. Duress Buttons
- B. Related Sections
 - 1. Section 087100 Door Hardware
 - 2. Section 260000 Electrical (including related sub-sections)
 - 3. Section 270000 Communications (including related sub-sections)
 - 4. Section 280000 Electronic Security
 - 5. Section 281000 Electronic Access Control and Intrusion Detection
 - 6. Section 282300 Video Surveillance
 - 7. Section 283100 Fire Alarm and Smoke Detection

1.2 REFERENCES

- A. See Section 280000 Electronic Security.

1.3 SYSTEM COORDINATION

- A. The Security Integrator shall completely coordinate all relevant work of other trades/systems including, but not limited to:
- B. Fire Alarm System
 - 1. Electrical Systems(s)
 - 2. Telecommunications System(s)
- C. Fire Alarm and Life Safety
 - 1. The security integrator shall coordinate the EID system with the life safety consultant to insure compliance with applicable codes and requirements.

1.4 GENERAL SYSTEM DESCRIPTION

- A. General Requirements

1. Furnish all labor, materials, tools, equipment, and services for a complete system as indicated and in accordance with provisions of the contract documents.
 2. Install per manufacturer's recommendations.
 3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, and devices incidental to or necessary for a sound, secure and complete installation.
 4. Comply with the provisions of Division 1 for General Requirements.
 - a) In the event of a conflict between the provisions of this Section and Division 1, the more stringent provisions shall apply.
 5. All system devices and components included shall be compatible.
- B. The project shall be equipped with a system that is an extension of an existing system maintained by Midwestern State University campus police.
1. All work required within the project for extension of the EID system to the existing system head end shall be furnished and installed by the project security contractor.
- C. The EID system will support the needs of the project in accordance with these specifications.
1. The EID system shall have the capability for future expansion to support the security needs of the completed complex.
- D. EID systems utilized for life safety shall comply with all applicable codes.
- E. Emergency/UPS power will be utilized to power the EID system's components at the Security head end equipment location.

1.5 EMERGENCY PHONE

- A. Provide outdoor rated, ADA-compliant hands-free Emergency Phones and compatible with the existing system.
1. Vandal resistant stainless steel faceplate.
 2. Provide buttons for emergency and non emergency calls
 3. Support SIP protocol
 4. Provide call status LEDs
- B. Emergency Phone Tower
1. Provide Blue LED/CFL light to attract attention.
 - a) The Lighting powered from an power source.
 2. Coordinate with owner on tower color and graphics
 - a) Coordinate with Section 282300
 - b) Coordinate with owner on the orientation of camera mounting arm to mitigate the camera blind spot caused by the arm
- C. Emergency Phone Wall Mounted Enclosure

1. Provide Blue LED/CFL light to attract attention.
 - a) The Lighting powered from an emergency power source.
2. Coordinate with owner on housing color and graphics

1.6 IP Based Video Intercom System

- A. Computer Based Master Station
 1. Provide PTZ control of substation camera
 2. Hands-free VOX communication
 3. Door release control
 4. Provide software and install on owner provided PCs
 5. Provide microphone and speakers for owner provided PCs
- B. Hardware Based Master Station
 1. Provide PTZ control of sub station camera
 2. Handset or Hands-free VOX/ PTT communication
 3. Door release control
 4. Wall or Desk Mounting
 5. PoE (802.3af) powered
- C. Video Sub Station
 1. Digital PTZ color camera
 2. Dry Contact for Door Release
 3. LED illumination for nighttime viewing
 4. IP addressable
 5. PoE (802.3af) powered
- D. Control Unit (as required)
 1. Rack mounted

1.7 AREA OF REFUGE EMERGENCY PHONE

- A. Provide at designated locations an ADA compliant hands free Emergency Phone
 1. Shall be compatible with the Area of Refuge base station.
 2. Shall be phone line powered or have battery backup power
 3. Phone operation indicator for the hearing impaired
 4. Operate over the owner's voice phone network
 - a) Coordinate with owner for routing and patching in IDF
 5. Auto-dialer shall support calling a second number if the first number does not answer
 6. Provide at each Emergency Phone an Area of Refuge Instruction Sign
 7. Provide recordable location identifier to identify the calling phone's location
 8. Communication pathway shall have at least a Level 2 Pathway Survivability.

- a) As per NFPA 72, Level 2 Pathway Survivability shall consist of one or more of the following:
 - 1) 2-hour fire-rated circuit integrity (CI) cable
 - 2) 2-hour fire-rated cable system [electrical circuit protective system(s)]
 - 3) 2-hour fire-rated enclosure or protected area
 - 4) 2-hour performance alternatives approved by the authority having jurisdiction
- b) Install Emergency Phone and communication pathway(s) per all current applicable life safety, fire alarm, building, and electrical codes.

1.8 DURESS PANIC BUTTONS

- A. The Duress panic button is a switch that allows an individual to covertly send a duress signal, with no visible or audible indication when activated.
 - 1. Wired Duress Button
 - a) Switch shall have a shroud over the activating lever that locks in activated position until reset with a key or have two buttons that must be press simultaneously to send alarm

1.9 SUBMITTALS

- A. Follow provisions of Section 280000 additional requirements.

1.10 QUALITY ASSURANCE

- A. Follow provisions of Section 280000.
- B. Spare Parts:
 - 1. Providespare components for every model and configuration of electronic components and devices used on the project as spare parts inventory.
 - a) The security integrator will turn over the new and unused components and devices to the owner at project closeout.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Follow provisions of Section 280000.

1.12 PROJECT/SITE CONDITIONS

- A. Follow provisions of Section 280000.

1.13 WARRANTY

- A. Follow provisions of Section 280000.
- B. All devices and components shall comply with applicable U.L. standards.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SYSTEM MANUFACTURERS

- A. Emergency Duress Buttons
 - 1. United Security
 - 2. Ademco 269
 - 3. Viking PB-1
 - 4. Owner Approved Equivalent
- B. Wireless Duress Pendant
 - 1. AC/ID System compatible (reference specification 281000)
 - 2. Owner Approved Equivalent
- C. Security Intercom System
 - 1. Aiphone
 - 2. Commend
 - 3. Stentofon
 - 4. Talk-A-Phone
 - 5. Owner Approved Equivalent
- D. Video Intercom System
 - 1. Aiphone
 - 2. Commend
 - 3. Siedle
 - 4. Stentofon
 - 5. Owner Approved Equivalent
- E. Emergency Phone
 - 1. Aiphone
 - 2. Code Blue
 - 3. Commend
 - 4. Stentofon
 - 5. Talk-A-Phone
 - 6. Owner Approved Equivalent
- F. Emergency Phone Wall Mount Enclosure
 - 1. Code Blue
 - 2. Talk-A-Phone
 - 3. Owner Approved Equivalent
- G. Emergency Phone Tower

1. Code Blue
2. Talk-A-Phone
3. Owner Approved Equivalent

H. Area of Rescue Emergency Phone

1. Talk-A-Phone
2. Rath Microtech
3. Owner Approved Equivalent

I. Wire & Cable

1. Windy City
2. General Cable
3. Belden
4. Owner Approved Equivalent

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Power Supplies

1. Provide device power supplies for all security system devices requiring power
2. Provide power distribution boards with independently fused outputs.
3. Power supply requirements:
 - a) Sealed gel battery backup to provide continuous operation during power failure.
 - 1) Provide batteries as required to provide specified battery backup time for a fully loaded power supply, regardless of the connected load.
 - b) A battery charger to maintain the battery.
 - c) Low battery and power fail contacts to monitor the status of the input power and the battery.
 - d) Key lockable wall mount metal enclosure with tamper switch.

B. Video Surveillance System Integration

1. Automatic Video Call-up
 - a) Intercom / Phones shall position PTZ cameras and call-up all cameras in the area, to the alarm assessment workstation
 - b) Record video of alarm calls

C. Tamper Resistant Screws

1. Provide appropriate screw heads for each application (e.g. countersunk heads for recessed cover plate screws, flat head screws for standard junction box covers, etc.).
2. The security integrator shall provide Torx® tamper resistant screws for:
 - a) Security device cover plates

- b) Duress buttons

3.2 FURTHER REQUIREMENTS

- A. Refer to provisions of Section 280000.
- B. Furnish and coordinate installation of all special device back boxes and field devices as shown on the security drawings and as specified in this section.
- C. The exact installation locations of all equipment shall be coordinated and verified with the Contractor prior to installation.
 - 1. Subcontractor shall notify the Contractor if any location appears to be unsuitable.
- D. Labeling
 - 1. Provide labeling suitable to Owner for all major equipment components.
 - a) Coordinate with Owner on numbering scheme to match existing.
 - 2. Provide labeling for all security equipment racks and enclosures.
 - 3. Provide labeling for all security device wiring.
 - a) Label all cables and wiring using waterproof, self-adhesive computer printed labels. Label both ends of each cable.
 - b) At multi conductor cable terminations label each conductor.
- E. Coordinate with the Telecommunications Subcontractor for data network connections and telephone circuits as required.
- F. Prepare all systems for user operation.
 - 1. The security system must be complete and ready to operate prior to Owner final acceptance of the system.
- G. Coordinate with the Owner for all system programming requirements.
- H. Perform database programming as required to support the security sub-system integration, and control panel configuration as required.

END OF SECTION 282600

SECTION 283100

FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. Delegated Design requirements for system design.
2. Fire-alarm control unit (panel).
3. Remote annunciator.
4. System printer.
5. Manual fire-alarm boxes.
6. System smoke detectors.
7. Nonsystem smoke detectors.
8. Heat detectors.
9. Notification appliances.
10. Device Guards.
11. Magnetic door holders.
12. Addressable interface devices.
13. Digital alarm communicator transmitter.
14. Radio alarm transmitter.
15. Firefighters' Smoke Control Station (panel).

B. FIRE ALARM SYSTEM BASIC DESCRIPTION

1. Fire alarm systems is a delegated design system.
2. The associated project drawings for the fire alarm system are intended to show general guidelines for the placement of fire alarm devices as they relate to other (non-fire alarm) systems and for permitting purposes. The final fire alarm plans to be submitted for AHJ approval shall be produced and sealed by a NICET level III certified designer; refer to the specifications (project manual) for further requirements. The designer shall provide all devices shown on these drawings and any additional devices or components required for a complete system. If other devices are anticipated to be required for proper system functionality, compliance with national and local codes or approval of the AHJ. The contractor shall qualify their bid and shall provide an add-alternate price making note of the specific anticipated additional requirements.
3. The fire alarm system shall be provided to meet the requirements of the authority having jurisdiction and latest edition of NFPA 72. The system shall be complete with detectors, manual fire alarm boxes (pull stations), audible and visual signal devices, a voice communication system, and link with the atrium smoke exhaust system. The system shall be a network based analog-addressable fire alarm system including class a wiring and voice evacuation notification. The main control panel shall be located at the AHJ approved location in the building along with a remote annunciator located at each main entry/exit door and one in the Data Center room. The system shall have a graphic interface. Fire alarm devices shall be provided as required by code and the AHJ. Manual fire alarm boxes shall be provided as required by code and the AHJ. Manual fire alarm boxes shall be located at all exits and at all doors leaving a floor. Smoke detectors shall be located within five feet of all magnetically held doors and in any space open to the corridor.
 - a. System smoke and heat detectors for pre-action fire protection systems shall be provided in the data center room.

- b. Duct-mounted smoke detectors shall be installed in the supply and return of all air handling units and at each smoke and fire/smoke damper. Additional duct detectors and smoke detectors shall be located as required for smoke control systems.
 - c. Audible/visual (A/V) alarms shall be located throughout the facility in accordance with latest requirements of NFPA 72 and ADA. Wall-mounted speaker-strobes shall be the primary notification appliance used throughout the facility.
 - d. Visual devices shall not be installed in teaching patient rooms or patient treatment areas (ex. Operating rooms, imaging treatment rooms, etc.) Per exceptions allowed by ADA and as allowed by AHJ.
 - e. Fire suppression system (sprinkler) tamper switches, flow switches, and pressure indicating alarms (on dry and pre-action systems) shall be connected to the fire alarm system.
 - f. Smoke and heat detectors for elevator recall shall be connected to the fire alarm system.
4. Fire alarm zoning shall be per code and AHJ requirements. Multiple electrical circuits and relays shall be provided to achieve proper zoning. A smoke compartment shall be the notification zone.
5. Upon activation of any manual or automatic alarm:
- a. All A/V alarms shall be activated throughout the facility. System shall be capable, thru programming, of floor-by-floor and compartment-by-compartment notification as acceptable by the AHJ.
 - b. All magnetically held doors shall be released.
 - c. All air handlers and smoke dampers not used for a specialized smoke control scheme shall close on a per zone basis.
 - d. Automatic notification of the fire department shall occur.
6. Fire alarm system interface with the smoke control system shall be in accordance with the prescriptive requirements of the fire protection engineer. An emergency responder DAS system shall be provided throughout the building for fire fighter communications.

1.2 DEFINITIONS

- A. Definitions in NFPA 72 apply to fire alarm terms used in this Section
- B. CPVC: Chlorinated Poly Vinyl Chloride
- C. EPO: Emergency Power Off System.
- D. FAAP: Fire Alarm Annunciator Panel (Remote Annunciator).
- E. FACP: Fire Alarm Control Unit (Panel).
- F. FSCS: Firefighters' Smoke Control Station (panel).
- G. IDC: Initiating Device Circuit
- H. LED: Light-emitting diode
- I. NAC: Notification appliance circuit.
- J. NICET: National Institute for Certification in Engineering Technologies.
- K. NRTL: Nationally Recognized Testing Laboratory

L. SLC: Signaling Line Circuit

1.3 SYSTEM DESCRIPTION

- A. Noncoded, UL-certified] addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only. The system shall detect fire conditions, alarm the building occupants of a fire condition, control the necessary systems to suppress fire and smoke and shall summon the local Fire Department automatically without the need for human intervention/human action.
- B. The fire alarm system shall be a microprocessor based network system with graphical workstation that includes a pictorial image of the protected premises.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: These specifications and the accompanying Drawings define the intent of the fire alarm system to be provided. In addition to the system as specified herein and shown on the Drawings, provide all planning, design, calculations, equipment, devices, raceways, boxes, cabling, system programming and any other component or service required for a complete, fully operational and code compliant system.
 - 1. Premises protection includes Construction Type and Occupancy
- B. Survivability of System: Fire-alarm control system and all associated circuits shall withstand attack by fire in accordance with "Protected Premises Fire Alarm Systems" Chapter of NFPA 72. Provide a two-hour fire rating for all notification appliance circuits, communications circuits, and NAC Power Extender trigger circuits, and other circuits necessary to ensure the continued operation of the emergency communications system which are outside the evacuation signaling zone.
 - 1. The two-hour rating shall consist of any of the following:
 - a. Two-hour rated cabling in conduit system to the evacuation signaling zone. Cabling shall be constructed in accordance with UL Fire Resistance Directory (FHJR) and conduit system shall be constructed in accordance with UL Fire Resistance Directory (FHIT).
 - b. Cabling in conduit which is encased in a minimum 50 mm (2 in.) of concrete to the evacuation signaling zone.
 - c. Cabling in conduit which is routed within fire resistant enclosures or protected areas to the evacuation signaling zone. Fire resistant enclosures shall be constructed in accordance with UL Fire Resistance Directory (FHIT).
 - d. Cabling in conduit which is enclosed in fire resistant materials to the evacuation signaling zone. System must be part of an electrical circuit protective material (FHIY) listed in UL Fire Resistance Directory.
 - 2. For audible notification circuits, the two-hour rating must extend from the amplifiers/voice command center to each evacuation signaling zone. Audible notification circuits within the evacuation signaling zone they serve may be non-rated cable.
 - 3. For visible notification circuits, the two-hour rating must extend from the FACP triggering the NAC Power Extender to the evacuation signaling zone where the NAC Power Extender is located. NAC trigger circuits and NAC output circuits within the evacuation signaling zone they serve may be non-rated cable.
- C. System Zoning: Fire-alarm control system and all associated circuits shall be arranged to comply with zoning requirements of NFPA 72 and the following:
 - 1. In association with the AHJ, determine the evacuation signaling zones by the entire building, by each smoke compartment, or by each floor.

2. Display each intelligent addressable device at the main fire alarm control panel in accordance with the following:
 - a. Use a unique alphanumeric label identifying each device location.
 - b. Include a descriptive reference with alphanumeric label that corresponds to devices' specific location and zone.
 - c. Comply with the Owner's labeling methodology requirements. Present proposed labeling methodology to Owner and Engineer prior to implementation.
- D. Voltage Drop Calculations: Design system for a maximum of 10 percent voltage drop for each notification appliance circuit.
- E. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section "Common Work Results for Electrical".
- B. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section "Common Work Results for Electronic Safety and Security" for products specified under PART 2 - PRODUCTS.
- C. General Submittal Requirements:
 1. Submittals shall be approved by Architect prior to submitting them to authorities having jurisdiction.
 2. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
- D. Simultaneous Action Submittals: Product Data, Delegated-Design Submittal, and Delegated-Design Shop Drawings submittal shall be submitted simultaneously.
- E. Product Data: For each type of product indicated, include the following:
 1. Supervisory power usage.
 2. Alarm power usage.
 3. Physical dimensions of equipment.
 4. Finish.
 5. Mounting requirements.
 6. Performance parameters and installation details for each type of detector.
 7. Performance parameters for duct-mounted detectors verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
- F. Delegated-Design Submittal: For fire-alarm system. Signed and sealed by the qualified professional responsible for their preparation. Include the following:
 1. Circuit loading and voltage drop calculations for each circuit. Include voltage drop calculations for notification appliance circuits.
 2. Battery-size calculations in a spreadsheet type format with a complete listing of all devices, quantities, individual component supervisory current and alarm current. Indicate the total supervisory and alarm currents, hours of backup, minutes in alarm and total battery amp-hour rating.

3. Calculations for selecting the spacing and sensitivity of detection devices.
 - a. Include calculations for area and duct-mounted detectors.
 4. Mathematical justification for audible notification device placement to meet code required sound dB levels.
 5. Complete sequence of operation of the fire alarm system.
 6. System Input-Output Matrix.
- G. Delegated-Design Shop Drawings: For fire-alarm system. Signed and sealed by the qualified professional responsible for their preparation. Include the following:
1. Plans, elevations, sections, details, and attachments to other work. Include floor plans to indicate final outlet locations showing address of each addressable device.
 - a. Prepare shop drawings using symbols and notes as recommended in NFPA 170 "Standard for Fire Safety and Emergency Symbols."
 - b. Include location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
 - c. Include location of each audible notification device, ratings of each, and installation details as needed to comply with NFPA 72 sound dB level requirement. Annotate to correspond with mathematical calculations.
 - d. Include location of each visible notification device, ratings of each, and installation details as needed to comply with NFPA 72. Annotate coverage patterns to show placement meets coverage requirements of NFPA 72.
 - e. Show size and route of cable and conduits.
 2. Dimensional drawings and elevations of all system enclosures including but not limited to the following:
 - a. Fire Alarm Control Unit (panel),
 - b. Remote Annunciators.
 - c. Firefighters' Smoke Control Station. Include elevation view of panel face drawn at full scale, including custom graphics.
 - d. Audio control panel
 - e. Voice/alarm signaling-service equipment rack or console layout, include grounding schematic and single-line connection diagram.
 3. One-line riser drawing for the entire system network indicating panel-to-panel conductors including type, size, quantity and specific function.
 4. System address and labeling methodology
 5. System wiring diagrams indicating interfaces to equipment supplied by others.
 6. Device "typical" wiring diagrams. These drawings shall indicate specific termination details for all peripheral equipment and/or interface devices.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Submit Coordination Drawings in accordance with Division 26 Section "Common Work Results for Electronic Safety and Security". Include the following:
1. Enlarged Equipment Room layouts.
 2. Reflected Ceiling Plans.
 3. Heating, ventilating, and air-conditioning duct drawings, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
- B. Qualification Data: For qualified Designer and Installer.
1. Copy of State license showing the fire alarm contractor to be certified in the layout and installation of fire alarm systems.
 2. Copy of NICET certification showing the fire alarm contractor to be certified in the layout, equipment selection, installation, acceptance testing, trouble-shooting, servicing and sales of fire alarm systems.

- C. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - 3. Record copy of site-specific software.
 - 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 - 5. Manufacturer's required maintenance related to system warranty requirements.
 - 6. Abbreviated operating instructions for mounting at fire-alarm control unit.
 - 7. Copy of NFPA 25 "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems".
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 3. Device address list.

1.8 QUALITY ASSURANCE

- A. Designer Qualifications: Shop Drawings shall be prepared and signed by personnel with the following qualifications:
 - 1. Trained and certified by manufacturer.
 - 2. Certified by NICET as minimum Level III or a qualified professional engineer.
 - 3. Licensed by authorities having jurisdiction.
- B. Installer Qualifications: Personnel shall be trained and certified by manufacturer and be certified by NICET as follows:
 - 1. Supervisor: Level III or higher.
 - 2. Technician: Level II or higher.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL listed or approved alarm company.
- F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- G. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FMG-approved alarm company.
- H. Comply with NFPA 70
- I. Comply with NFPA 72
- J. Comply with the Americans with Disabilities Act (ADA); including local amendments, modifications and additional accessibility requirements of the authorities having jurisdiction.
- K. Comply with International Standards Organization (ISO)
 - 1. ISO-9000
 - 2. ISO-9001

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Prepare products for shipment.
 - 1. Provide suitable packaging materials, crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
 - 2. Weatherproof packaging for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.
- B. Store products indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect products from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Handle product components according to manufacturer's written instructions.

1.10 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Comply with requirements defined in Division 28 Section "Common Work Results for Safety and Security".

1.11 COORDINATION

- A. Coordinate installation and operational requirements for automatic elevator recall, including but not limited to the recall signal time frame, with Division 14 and with authorities having jurisdiction.
- B. Coordinate installation and operational requirements for hoistway ventilation with Divisions 14 and 23.
- C. Coordinate installation and operational requirements for smoke control systems with Division 23.

- D. Coordinate installation and operational requirements for fire-protection systems, including but not limited to water-based sprinkler system and pre-action sprinkler system with Division 21.
- E. Coordinate installation and operational requirements for duct mounted smoke detectors with Division 21 and 23.

1.12 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.13 MAINTENANCE AGREEMENT

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide full inspection and maintenance by skilled employees of manufacturer's designated service organization during the Warranty period, including any special warranty period specified.
 - 1. Include inspection, maintenance, testing, and repair contract in compliance with the manufacturer's recommended routine preventive maintenance program and NFPA 72 requirements necessary to maintain full ongoing listing on the complete installed system.
 - 2. Provide parts and supplies same as those used in the manufacture and installation of the original equipment.
 - 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.
- B. Extended Maintenance Service: Offer for the Owner's consideration and evaluation at the time of Product Data Submittal, a priced inspection, maintenance, testing, and repair contract in compliance with the manufacturer's recommended routine preventive maintenance program and NFPA 72 requirements necessary to maintain full ongoing listing on the complete installed system.
 - 1. The services offered under this contract shall begin after the completion of the Initial Maintenance Service and Warranty Period.
 - 2. The Owner shall have the option of renewing for single or multiple years, up to five years, at the price quoted upon completion of the Warranty period.
 - 3. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification and listing of the completed system.

PART 2 - MANUFACTURERS

2.1 Manufacturer

- A. Manufacturers: Determine the prevalent manufacturer for the campus fire alarm systems and use this system as the base system. All others shall submit a system proposal as a substitute manufacturer. Subject to compliance with requirements, provide products by the base system one of the following:

1. GE Infrastructure; a unit of General Electric Company.
2. NOTIFIER; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.
4. SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Alarm signals:

1. Fire-alarm signal initiation (General Alarm) shall be by one or more of the following devices and systems:
 - a. Manual Fire-Alarm Boxes.
 - b. Heat detectors.
 - c. Smoke detectors.
 - d. Duct-Mounted smoke detectors.
 - e. Automatic sprinkler system water flow.
 - f. Heat detectors in elevator shaft and pit.
 - g. Fire-extinguishing system operation including but not limited to dry-pipe sprinkler system and pre-action sprinkler systems.
2. Supervisory signal initiation (Supervisory Alarm) shall be by one or more of the following devices and actions:
 - a. Valve supervisory switch. (Operation of a fire-protection system valve tamper switch.)
 - b. Low-air-pressure switch of a dry-pipe sprinkler system.
 - c. Low-air-pressure switch of a pre-action sprinkler system.
 - d. Fire-pump running.
 - e. Fire-pump power failure, including a dead-phase or phase-reversal condition.
 - f. Elevator shunt-trip supervision.
3. System trouble signal initiation (Trouble Alarm) shall be by one or more of the following devices and actions:
 - a. Open circuits, shorts, and grounds in designated circuits.
 - b. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - c. Loss of primary power at fire-alarm control unit.
 - d. Ground or a single break in fire-alarm control unit internal circuits.
 - e. Abnormal ac voltage at fire-alarm control unit.
 - f. Break in standby battery circuitry.
 - g. Failure of battery charging.
 - h. Abnormal position of any switch at fire-alarm control unit or annunciator.

B. Alarm Actions:

1. Fire alarm signal (General Alarm) shall initiate the following actions:
 - a. Continuously operate alarm notification appliances as indicated. Notification of a General Alarm conditions within the protected premises shall be similar to the following methodology:
 - 1) Notification: In conjunction with the AHJ, determine the notification options below that are available for this building.
 - 2) Activate audible and visible indicating devices throughout the entire facility.
 - 3) Notification: Comply with the NFPA 72 requirements for Relocation and Partial Evacuation. Activate audible indicating devices throughout the entire facility with specific audio messages as listed below. Activate visible indicating devices throughout the evacuation signaling zone where the alarm signal originated. Provide custom programming to modify standard audio messages to comply with the Owners' evaluation protocol. Provide separate notification circuits as required to

accomplish the following audio messages and actions that shall occur simultaneously:

- a) An 'evacuation' message shall be sounded in the evacuation signaling zone where the alarm originated. The intent of this message to advise occupants hearing this message that they are near danger and should leave the zone in alarm immediately.
 - b) An 'alert' message shall be sounded throughout the remainder of the facility. It is the intent of this message to advise occupants that an alarm has been reported in the building and they should prepare for evacuation if necessary, but should remain in place until instructed to evacuate.
 - c) An 'instructional' message shall be sounded in the elevator cabs. It is the intent of this message to advise elevator occupants that an emergency exists, the elevator has been directed to the safe return floor, and that occupants should quickly exit the building.
 - d) Provide selective paging to each individual evacuation zone. In addition to the message/channels detailed above, a dedicated page channel shall be capable of simultaneously providing live voice instructions without interrupting any of the messages listed above.
 - e) Provide separate notification zone for selective manual paging for enclosed stairways. Automatic messages in stairwells are not permitted.
- 4) Notification: Comply with the NFPA 72 requirements for Relocation and Partial Evacuation. Activate audible indicating devices throughout the entire facility with specific audio messages as listed below. Activate visible indicating devices throughout the evacuation signaling zone where the alarm signal originated and in the evacuation zones immediately above and below the zone of origination. Provide separate notification circuits as required to accomplish the following audio messages and actions that shall occur simultaneously:
- a) An 'evacuation' message shall be sounded in the evacuation signaling zone where the alarm originated and in the evacuation zones immediately above and below the zone of origination. The intent of this message to advise occupants hearing this message that they are near danger and should leave the building immediately.
 - b) An 'alert' message shall be sounded throughout the remainder of the facility. It is the intent of this message to advise occupants that an alarm has been reported in the building and they should prepare for evacuation if necessary, but should remain in place until instructed to evacuate.
 - c) An 'instructional' message shall be sounded in the lobby. It is the intent of this message to advise lobby occupants to leave the lobby and clear the area for arriving firefighters.
 - d) An 'instructional' message shall be sounded in the elevator cabs. It is the intent of this message to advise elevator occupants that an emergency exists, the elevator has been directed to the safe return floor, and that occupants should quickly exit the building.
 - e) Provide selective paging to each individual evacuation zone. In addition to the message/channels detailed above, a dedicated page channel shall be capable of simultaneously providing live voice instructions without interrupting any of the messages listed above.

- f) Provide separate notification zone for selective manual paging for enclosed stairways. Automatic messages in stairwells are not permitted.
- 5) Notification: Comply with the NFPA 72 requirements for Relocation and Partial Evacuation. Activate audible indicating devices throughout the entire facility with specific audio messages as listed below. Activate visible indicating devices throughout the evacuation signaling zone where the alarm signal originated and in the evacuation zones immediately above and below the zone of origination. Provide custom programming to modify standard audio messages to comply with the Owners' evaluation protocol. Provide separate notification circuits as required to accomplish the following audio messages and actions that shall occur simultaneously:
 - a) An 'evacuation' message shall be sounded in the evacuation signaling zone where the alarm originated [and if required in the evacuation zones immediately above and below the zone of origination]. The intent of this message to advise occupants hearing this message that they are near danger and should leave the zone in alarm immediately.
 - b) An 'alert' message shall be sounded throughout the evacuation zone(s) adjacent to the zone of origination. It is the intent of this message to advise occupants that an alarm has been reported in an adjacent zone and to prepare for the arrival of evacuees.
 - c) An 'alert' message shall be sounded throughout the remainder of the facility. It is the intent of this message to advise occupants that an alarm has been reported in the building and they should prepare for evacuation if necessary, but should remain in place until instructed to evacuate.
 - d) An 'instructional' message shall be sounded in the lobby. It is the intent of this message to advise lobby occupants to leave the lobby and clear the area for arriving firefighters.
 - e) An 'instructional' message shall be sounded in the elevator cabs. It is the intent of this message to advise elevator occupants that an emergency exists, the elevator has been directed to the safe return floor, and that occupants should quickly exit the building.
 - f) Provide selective paging to each individual evacuation zone. In addition to the message/channels detailed above, a dedicated page channel shall be capable of simultaneously providing live voice instructions without interrupting any of the messages listed above.
 - g) Provide separate notification zone for selective manual paging for enclosed stairways. Automatic messages in stairwells are not permitted.
- b. Identify alarm at fire-alarm control unit and remote annunciators. Indication, notification and acknowledgement of alarm conditions at the fire-alarm control unit shall be similar to the following methodology:
 - 1) When the system control panel goes into alarm condition the normal indicator light shall extinguish and an alarm indicator light shall illuminate, a control panel audible alert (buzzer) shall pulsate.
 - 2) Visually indicate, via the system control panel LCD display, all applicable information associated with the status condition including; the real time, the number of messages waiting, the type of alarm, the alarm zone number, the device type, the device location, the time/date the alarm occurred and any user specified message(s).

- 3) The operator shall acknowledge the alarm/message by pressing an acknowledge button, and the buzzer shall silence providing there isn't an additional alarm pending. If there are additional alarms waiting the operator must acknowledge all pending alarms/messages before the buzzer will silence.
- 4) To silence audible devices and stop visible devices from flashing the operator may press the alarm silence button; a new alarm shall cause the audible and visible devices to resound/flash. The visible devices shall stop operating when the "Alarm Silence" button is pressed, failure to do so could result in confusion of hearing-impaired occupants.
- 5) To reset the system the operator shall press the reset button.
- 6) Any remote or local annunciator LCD/LED's associated with the status zone shall be illuminated.
- 7) The operator shall not be able to acknowledge or silence the alarm from a remote annunciator. All acknowledge and silence features are limited to the fire alarm control unit and fire command center locations.
- c. Transmit an alarm signal to the remote alarm supervising station.
 - 1) Operate alarm relay contacts to initiate the transmission of an alarm to the following:
 - a) A Central Monitoring Station retained by the Owner via an auto-dialer or within the system control panel.
 - b) A proprietary alarm central station operated by the Owner via a digital communications output within the system control panel.
- d. Unlock electric door locks in path of egress.
- e. Release fire and smoke doors held open by magnetic door holders.
 - 1) Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- f. Activate voice/alarm communication system.
- g. Display the event on the graphical workstation and display a pictorial image.
- h. Transmit signal to the facility management system, include address of initiating device.
- i. Interface with Security System.
- j. Transmit alarm text messages to "alpha-numerical" display pagers.
- k. Record events in the system memory.
- l. Record events by the system printer.
- m. Comply with additional sequences specified under the "Additional Specialized Alarm Actions" paragraph in Part 2 of this section.
2. System Trouble and Supervisory Signal Actions shall initiate the following actions:
 - a. Notification appliance and annunciate at the FACP and remote annunciators.
 - b. Record events in the system memory.
 - c. Record events by the system printer.
 - d. Display the event on the graphical workstation and display a pictorial image.
 - e. Transmit signal to the facility management system, include address of initiating device.
 - f. Transmit alarm text messages to "alpha-numerical" display pagers.
 - g. Transmit alarm signal to the remote supervising station.
 - 1) Operate alarm relay contacts to initiate the transmission of an alarm to the following:
 - a) A Central Monitoring Station retained by the Owner via an auto-dialer or within the system control panel.
 - b) A proprietary alarm central station operated by the Owner via a digital communications output within the system control panel.
 - h. Comply with additional sequences specified under the "Additional Specialized Alarm Actions" paragraph in Part 2 of this section.

- C. Additional Specialized Alarm Actions:
1. Fuel Supply Shutoff: Activate emergency fuel supply shutoff to start upon receipt of a General Alarm by the Fire Alarm Control Unit (panel). Comply with the following:
 - a. Operate control relay contacts to close solenoid valve(s) to shut-off designated gas and fuel supplies, not the emergency generator fuel supply. Coordinate and interface with Division 23.
 2. Elevator Recall: Activate elevator recall system to start in accordance with ANSI Standard A17.1 and NFPA 72. Comply with the following:
 - a. Initiate Elevator Recall Sequence to return elevators to their primary or alternate recall floors upon receipt of a General Alarm by the Fire Alarm Control Unit (panel).
 - b. Alarm-initiating devices, except those listed, shall not start elevator recall. Smoke detectors in locations indicated below shall initiate automatic elevator recall:
 - 1) Elevator lobby detectors.
 - 2) Smoke detector in elevator machine room.
 - 3) Smoke detectors in elevator hoistway.
 - c. Smoke detectors designated for Elevator Recall shall be connected to fire-alarm system. Initiate a General Alarm upon detection of smoke.
 - d. Actuation of the elevator lobby detector located on the designated primary recall floor shall signal the cars to move to the alternate recall floor.
 3. Elevator Shunt-Trip Operation: Heat detectors designated for elevator power removal shall be connected to fire-alarm system. Alarm-initiating devices, except those listed, shall not start elevator power removal.
 - a. Actuation of heat detectors in the locations indicated below shall shut down power, via a shunt trip operator, to the elevators associated with the location without time delay:
 - 1) Heat detector in elevator machine room; locate detector within two feet of each sprinkler head.
 - 2) Heat detectors in elevator hoistway; locate detector within two feet of each sprinkler head.
 4. Elevator Shunt-Trip Operation: Water-flow alarm connected to sprinkler in an elevator hoistway and elevator machine room shall shut down power, via a shunt trip operator, to elevators associated with the location without time delay. Alarm-initiating devices, except those listed, shall not start elevator power removal.
 - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated recall floor.
 5. Air-Handling System Shut-Down: Upon receipt of a General Alarm by the Fire Alarm Control Unit. Notification: Activate audible and visible indicating devices throughout the entire facility.
 - a. Operate control relay contacts to signal shutdown of the Air-Handling system(s) serving the evacuation signaling zone where the alarm signal originated. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands. Coordinate and interface with Division 23.
 - a. Shut the smoke or combination fire/smoke dampers at that specific air-handling units' supply and return connections. Shut all smoke and combination fire/smoke dampers associated with the air-handling system.
 - b. Provide for an adjustable time delay, initially set at 20 seconds, to delay the transmission of close signals to the dampers. The intent of this time delay is to allow the air-handling unit fan(s) to receive the stop signal and slow down before closing any dampers in order to avoid a high static-pressure alarm/trip on the air-handling system.

6. Atrium Smoke Control System: An alarm signal from a smoke detector, duct-mounted smoke detector, water flow, or other initiating device associated with smoke control system shall operate control relay contacts to initiate the smoke control system in accordance with the smoke control sequence specified on the Smoke Control Drawings.
 - a. Initiate General Alarm when the smoke control system is activated.
 - b. Coordinate and interface with Division 23.
 - c. Provide separate programmed initiation signals with the required quantity of control relays to meet the requirements of the smoke control sequence specified on the Smoke Control Drawings.
 - d. Smoke Control System may activate when a general alarm is received at fire-alarm control unit from initiating device other than those specifically listed in the smoke control sequence when required by the authorities having jurisdiction. Provide additional hardware and programming to accomplish this function when required by the AHJ.
7. Pre-Action Fire Suppression System (Option 1)
 - a. Detector Type: Detection within the protected area shall be provided by the following:
 - 1) Verified Detection: Sound alarm on activating single-detection device, and start extinguishing-agent discharge sequence on actuating second-detection device.
 - b. System Operating Sequence as follows:
 - 1) Actuating First Detector: Visible indication on annunciator panel, energize audible alarm and visible alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send trouble alarm signal to fire-alarm control unit.
 - 2) Actuating Second Detector: Visible indication on annunciator panel, energize audible and visible alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 60 seconds (adjustable), send trouble alarm signal to fire-alarm control unit,. At conclusion of time delay if an abort signal has not been received, release pre-action valve to allow water to fill sprinkler system, head must fuse to release water onto protected area allow water to fill sprinkler system, open heads immediately release water onto protected area. On agent discharge, send general alarm signal to fire-alarm control unit and operate audible and visible alarm appliance inside and immediately outside the protected area.
 - 3) Operating "Abort" switches shall delay extinguishing-agent discharge while being activated (constantly depressed); release delay timer will continue to run while the abort switch is depressed. Release of hand pressure on the switch will cause agent discharge if the time delay has expired. Switches must be reset to prevent agent discharge.
 - 4) Operating "Manual Discharge" switches shall immediately discharge extinguishing agent.
 - 5) Operating "EPO" switches will terminate power to protected equipment immediately on actuation but shall not initiate pre-action extinguishing agent sequence without actuation of smoke detector.
8. Pre-Action Fire Suppression System (Option 2)
 - a. Detector Type: Detection within the protected area shall be provided by the following:
 - 1) Cross-Zoned Air-Sampling Detection: Remote air-sampling detector system and spot photoelectric detectors reporting to a fully programmable microprocessor-based control panel.
 - b. System Operating Sequence as follows:

- 1) First Detection Level (Alert): Mild audible and visible indication on annunciator panel. Visible device labeled "ALERT" flashes slowly in the protected area.
- 2) Second Detection Level (Action): Strong audible and visible indication on annunciator panel. Visible device labeled "ACTION" flashes rapidly in the protected area.
- 3) Third Detection Level (Fire 1): Visible indication on annunciator panel, energize audible and visible alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 60 seconds (adjustable), send trouble alarm signal to fire-alarm control unit,. At conclusion of time delay if an abort signal has not been received, release pre-action valve to allow water to fill sprinkler system, head must fuse to release water onto protected area ~~[allow water to fill sprinkler system, open heads immediately release water onto protected area.]~~ On agent discharge, send alarm signal to fire-alarm control unit and operate audible and visible alarm appliance inside and immediately outside the protected area.
- 4) Fourth Detection Level (Fire 2): Same as Fire 1.
- 5) Actuation of photoelectric smoke detector in zone shall initiate agent discharge sequence as described for the third detection level (Fire 1) above.
- 6) Operating "Abort" switches shall delay extinguishing-agent discharge while being activated (constantly depressed); release delay timer will continue to run while the abort switch is depressed. Release of hand pressure on the switch will cause agent discharge if the time delay has expired. Switches must be reset to prevent agent discharge.
- 7) Operating "Manual Discharge" switches shall immediately discharge extinguishing agent.
- 8) Operating "EPO" switches will terminate power to protected equipment immediately on actuation but shall not initiate pre-action extinguishing agent sequence without actuation of smoke detector.

2.3 FIRE-ALARM CONTROL UNIT (PANEL)

A. General Requirements for Fire-Alarm Control Unit:

1. The system shall have the capability of being activated into alarm, supervisory and trouble modes of operation from both manual and automatic devices.
2. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
4. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: LCD Touchscreen or Liquid-crystal type, with minimum of 2 line(s) of 40 characters.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameter.
- C. Smoke-Alarm Verification: Provide input module and appurtenances necessary for Smoke-Alarm Verification. Program smoke-alarm verification sequence in accordance with sequence of operation.
- D. Notification Appliance Circuit: Operation shall sound in same pattern as existing system.
- E. Elevator Recall: Provide an output signal using an addressable relay to start elevator recall sequence in accordance with sequence of operation.
- F. Smoke Control System: Provide an output signal using an addressable relay to start the smoke control system.
- G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- H. Transmission to Remote Supervising Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- I. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet or as a special module that is part of fire-alarm control unit.
1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones ~~and the status of firefighters' two-way telephone communication zones.~~
 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

- K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters, where provided, shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Sealed lead calcium.
- M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit.
 - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.5 SYSTEM PRINTER

- A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

2.6 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit if acceptable by the AHJ.Otherwise provide,
 - 2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 - 3. Station Reset: Key- or wrench-operated switch.
 - 4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to manual fire alarm box to initiate an alarm. Lifting the protective shield actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.7 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
 - 1. Comply with UL 268; operating at 24-V dc, nominal.
 - 2. Detectors shall be two-wire or four-wire type, as required.

3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 5. Integral Visible-Indicating Light: LED type indicating detector has operated and power-on status.
 6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Duct-Mounted Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 4. Remote test station with keyswitch, red LED alarm indicator, and green power-on LED.
 5. Each sensor shall have multiple levels of detection sensitivity.
 6. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 7. Provide relay at each duct-mounted detector for Fan Shutdown, Smoke Damper actuation or Fire/Smoke Damper actuation. Contacts rated to interrupt control circuit.
 8. Provide relay at each detector located at an air-handling unit to interface with the Facility Management System (FMS) and communicate the device address and status.
- D. Beam-Type Smoke Detector: Each detector shall consist of a separate transmitter and receiver, and shall have the following features:
1. UL 268 listed, operating at 24-V dc, nominal.
 2. Adjustable Sensitivity: At least six sensitivity levels, settable at the receiver, measured as percent of obscuration.

3. Two selectable alarm delay settings, allowing each to be associated with a corresponding sensitivity.
 4. Trouble signal delay, fixed at 20 seconds.
 5. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status with remote indicator panels.
- E. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a high efficiency aspirator laser-based photoelectric detector, a sample transport fan, and a control unit.
1. UL 268 listed, operating at 24-V dc, nominal.
 2. Pipe Network: Recessed piping network to connect control unit with sampling ports.
 - a. Piping Material: CPVC piping meeting requirements of UL 1887 "Standard for Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics." Pre-marked with "SMOKE DETECTOR SAMPLING TUBE – DO NOT DISTURB".
 3. Sampling Ports: Nozzle-type detector sampling orifice connected to piping network with flexible tubing.
 4. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of three preset values. Two-stage filtration system with HEPA final filter.
 5. Smoke Detector System Memory: Nonvolatile type.
 6. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg (12.5 Pa) at all sampling ports.
 7. Control Unit: Single-zone or multi-zone unit as indicated. Provides same system power supply, supervision, and alarm features as specified for the central fire-alarm control unit plus separate trouble indication for airflow and detector problems.
 8. Signals to the Central Fire-Alarm Control Unit: Any type of local system trouble is reported to the central FACP as a composite "trouble" signal. Alarms on each system zone are individually reported to the central Fire-Alarm Control Unit as separately identified alarm zones.

2.8 NONSYSTEM SMOKE DETECTORS

- A. Single-Station Smoke Detectors:
1. Comply with UL 217; suitable for NFPA 101; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
 2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
 3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet according to UL 464.
 4. Visible Notification Appliance: 177-cd strobe.
 5. Heat sensor, 135 deg F combination rate-of-rise and fixed temperature.
 6. Test Switch: Push to test; simulates smoke at rated obscuration.
 7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
 8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 10. Integral Visible-Indicating Light: LED type indicating detector has operated and power-on status.
- B. Single-Station Duct-Mounted Smoke Detectors:
1. Comply with UL 268A; operating at 120-V ac.

2. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot when tested according to UL 268A.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.9 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute, unless otherwise indicated.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Continuous Linear Heat-Detector System:
 1. Detector Cable: Rated detection temperature 155 deg F. NRTL listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short-circuit wires at the location of elevated temperature.
 2. Control Unit: Two-zone or multizone unit as required. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
 3. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
 4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as required by AHJ, equipped for mounting and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting and with screw terminals for system connections.
- B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the device faceplate.
 1. Rated Light Output: 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted, unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, red with white lettering or white with red lettering, as approved by the Architect.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- D. Voice/Tone Notification Appliances:
1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
 2. High-Range Units: Rated 2 to 15 W.
 3. Low-Range Units: Rated 1 to 2 W.
 4. Mounting: Flush, unless otherwise indicated.
 5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
- E. Low Frequency Tone Notification Appliances:
1. Appliances shall comply with UL and shall be listed and labeled by an NRTL.
 2. Alarm signal shall be a square wave or provide equivalent awakening ability.
 3. The wave shall have a fundamental frequency of 520 Hz \pm 10 percent.

2.11 CONDUCTORS AND CABLES

- A. Conductors and cables defined below shall be acceptable for used as approved by the AHJ.
- B. Optical Fiber Cable
1. Available Manufacturers: Provide products from manufacturers offering products that comply with requirements.
 2. Description: Multimode optical fiber cable.
 - a. Comply with ICEA S-83-596 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.3 for performance specifications.
 - c. Comply with TIA-492AAAB or TIA-492AAAA-A as applicable.
 - d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - e. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
 - f. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
 - g. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
- C. RS-232 Cable
1. Standard Cable: NFPA 70, Type CM.
 - a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. Polypropylene insulation.
 - c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - d. PVC jacket.
 - e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - f. Flame Resistance: Comply with UL 1581.

2. Plenum-Rated Cable: NFPA 70, Type CMP.
 - a. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - b. Plastic insulation.
 - c. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - d. Plastic jacket.
 - e. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - f. Flame Resistance: Comply with NFPA 262.

D. Fire Alarm Wire And Cable

1. Available Manufacturers: Provide products from manufacturers offering products that comply with requirements.
2. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
3. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
 - a. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
4. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - a. Low-Voltage Circuits: No. 16 AWG, minimum.
 - b. Line-Voltage Circuits: No. 12 AWG, minimum.
5. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

E. Circuit Class and Style:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 - a. Install no more than 50 addressable devices on each signaling line circuit.
2. Initiating Device, and Signaling Line Circuits: NFPA 72, Class A.
 - a. Install no more than 50 addressable devices on each signaling line circuit.
3. Notification Appliance Circuits: NFPA, Class B.
4. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class B.
 - a. Install no more than 50 addressable devices on each signaling line circuit.
5. Serial Interfaces: Two RS-232 ports for printers.

2.12 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
1. Factory fabricated and furnished by manufacturer of device.
 2. Finish: Paint of color to match the protected device.

2.13 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
 3. Rating: 24-V ac or dc.

- B. Material and Finish: Match door hardware.

2.14 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to the following:
 - 1. Elevator controller to initiate elevator recall.
 - 2. Circuit-breaker shunt trip for elevator power shutdown.
 - 3. Atrium Smoke Control System.

2.15 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply or loss of power.
 - 5. Low battery.
 - 6. Abnormal test signal.
 - 7. Communication bus failure.

- E. Secondary Power: Integral rechargeable battery and automatic charger.

- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.16 RADIO ALARM TRANSMITTER (as required by AHJ)

- A. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.
- B. Comply with 47 CFR 90.

- C. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.
1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 3. Normal Power Input: 120-V ac.
 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 7. Antenna-Cable Connectors: Weatherproof.
 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.
- D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 6. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.17 FIREFIGHTERS' SMOKE CONTROL STATION (PANEL)

- A. A firefighters' smoke control panel shall be provided and shall include manual control or override of automatic control for mechanical smoke-control systems. The HVAC control and supervisory functions of the panel shall be coordinated with the energy management system functions to assure proper automatic and manual operation of system equipment. Coordinate interface requirements with applicable Division 23 Sections.
- B. Comply with UL 864 and Listed to UUKL.
- C. Comply with NFPA 92A

- D. Comply with NFPA 92B
- E. Enclosure Construction: Cold rolled steel with welded and ground seams and finished with a black powder textured finish.
 - 1. Door: attached with concealed stainless steel piano hinge. Door fastened with keyed lock with no other fasteners visible. Finished with a powder textured finish.
- F. Control system for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override, the presence of power down stream of all disconnects and, through a pre programmed weekly test sequence report, abnormal conditions audibly, visually and by printed report.
- G. The panel shall be designed to graphically depict the building arrangement and smoke-control system zones served by the systems. The status of each smoke-control zone shall be indicated by lamps and appropriate legends. Refer to Drawings for additional details.
- H. The graphic display shall be a lamination which consists of a velvet textured polycarbonate face, a reverse printed image and a 1/8" aluminum backing. The display shall be printed with pigmented inks, for long life, on UL94VO flame retardant grade lexan. The graphic must have full color capacity to show different colors for supply, exhaust, and pressurization. A velvet texture finish must be applied to the polycarbonate face to eliminate glare. A dry erase coating shall be applied to display, when required.
- I. LEDs shall protrude through the laminate for 180 degrees visibility. They shall be wired to designated terminals for interface with remote controllers.
- J. Fans, major ducts, dampers, and door and window operators within the building that are portions of the smoke-control systems shall be shown on the panel and shall be shown connected to their respective ducts with a clear indication of the direction of airflow.
- K. AHU switches must be UL recognized components with a minimum rating of 24 VDC/AC, lamp. They shall be wired to designated terminals for interface with remote controllers.
- L. Provide relay controls to operate all automatic doors and windows associated with the smoke-control systems.
- M. Devices, switches, indicators and the like shall bear identifying legends.
- N. Status indicators shall be provided for all smoke-control equipment and annunciated by fan and zone, by pilot lamp-type indicators as follows:
 - 1. Fans, dampers and other operating equipment in their normal or "on" status: WHITE.
 - 2. Fans, dampers and other operating equipment in their "off" or closed status: RED.
 - 3. Fans, dampers and other operating equipment in their "on" or open status: GREEN.
 - 4. Fans, dampers and other operating equipment in a fault status: YELLOW/AMBER.
- O. Provision for testing the pilot lamp on the panel by means of one or more "lamp test" momentary push buttons or other self-restoring means shall be included. Light-emitting diodes may be used in lieu of pilot lamps with prior approval of authorities having jurisdiction.
- P. Provide Key Enable Switch, and a Power On LED.
- Q. The fault status shall be further identified by pulsing the indicator lamp.

- R. The panel shall provide control capability over the complete smoke-control system equipment within the building as follows:
1. ON-AUTO-OFF control over each individual piece of operating smoke-control equipment that can also be controlled from other sources within the building.
 2. OPEN-AUTO-CLOSE control over all individual dampers relating to smoke control and that are also controlled from other sources within the building.
 3. ON-OFF or OPEN-CLOSE control over all smoke-control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the panel.
- S. The panel actions shall be as follows:
1. The panel control actions shall have the highest priority of any control point within the building. Once issued from the panel, no automatic or manual control from any other control point within the building shall contradict the control action. Where automatic means is provided to interrupt normal, non-emergency equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct freezestat, duct-mounted smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices), such means shall be capable of being overridden by the panel control action and the last control action as indicated by each panel switch position shall prevail. In no case shall control actions require the smoke control system to assume more than one configuration at any one time.
 2. Only the AUTO position of each three-position control panel switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL non-emergency, building control position. When a panel is in the AUTO position, the actual status of the device (on, off, open, closed) shall continue to be indicated by the status indicator described above. When directed by an automatic signal to assume an emergency condition, the NORMAL position shall become the emergency condition for that device or group of devices within the zone. In no case shall control actions require the smoke control system to assume more than one configuration at any one time.
- T. Atrium smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke-control systems shall activate individual components (such as dampers and fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts and other equipment. The total response time for individual components to achieve their desired operating mode shall not exceed the following:
- | | |
|--|--------------------|
| 1. Control air isolation valve | Immediately |
| 2. Smoke damper closing | 15 seconds |
| 3. Smoke damper opening | 15 seconds maximum |
| 4. Fan starting (energizing) | 15 seconds maximum |
| 5. Fan stopping (de-energizing) | Immediately |
| 6. Fan volume modulation | 30 seconds maximum |
| 7. Pressure control modulation | 15 seconds maximum |
| 8. Temperature control safety override | Immediately |
| 9. Positive indication of status | 15 seconds maximum |
- U. For purposes of smoke control, the panel response time shall be the same for automatic or manual smoke-control action initiated from any other building control point.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Fire-Alarm Control Unit (FACP) Locations: Provide control units in the following locations, unless otherwise indicated:
 - 1. Lobby
- B. Remote Alarm Annunciator Panel (FAAP) Locations: Provide Remote Alarm Annunciator panels in the following locations, unless otherwise indicated:
 - 1. Locations as indicated on the Drawings or defined herein.
- C. Fire Fighters' Smoke-Control Station (FSCS) Location: Provide Smoke-Control Station in the following locations, unless otherwise indicated:
 - 1. Lobby.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Comply with NECA 305 "Standard for Fire Alarm System Job Practices" as published by the National Electrical Contractors Association.
- C. Comply with NFPA 92A, 92B, and IBC chapter 9 for installation of Firefighters' Smoke-Control Station.
- D. Equipment Mounting: Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
 - 1. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Smoke- or Heat-Detector Spacing:
 - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - 3. Smooth ceiling spacing shall not exceed the listing of the detector.
 - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 - 5. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or 3 feet from return-air opening.
 - 6. Lighting Fixtures: Locate centerline of detectors not closer than 12 inches from any part of a lighting fixture.
- F. Duct-Mounted Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes within 10' of straight duct and so they extend the full width of duct. Where installation within 10' of straight duct is not feasible, provide additional sampling tubes as required to protect ductwork branches.
- G. Heat Detectors in Elevator Shafts: Coordinate temperature rating, thermal response characteristic and location with sprinkler rating and location.
- H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms within the respective suite to sound.

- I. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- J. Notification Devices: Install devices with appropriate backbox and raceway according to room finish (i.e. flush mounted devices in recessed backboxes with concealed conduit in finished spaces; surface mounted boxes with exposed conduit in unfinished spaces. Refer to Architectural Documents for room finish types.
- K. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- L. Antenna for Radio Alarm Transmitter, if necessary: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a gust factor of 1.3 without damage.

3.3 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
 - 3. Cables, raceways, and support pathways, including but not limited to j-hooks and cable tray, that are used for fire alarm circuits and equipment control wiring associated with the fire alarm system shall not contain any other wire or cable.
 - 4. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- B. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
- D. Wiring Method for vertical risers penetrating floor slabs: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
- E. Wiring Method for circuits concealed in Walls, Partitions, and Inaccessible Ceilings: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
- F. Wiring Method for surface mounted and other exposed circuits, including in Crawlspace: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
- G. Wiring Method for circuits concealed in accessible ceilings, install plenum-rated fire alarm cables supported on j-hooks or cable tray as space may be available by coordination with the tele-data com system.
 - 1. For wall mounted devices: Install recessed device back boxes with conduit extended to above accessible ceiling according to Division 26 Section "Raceways and Boxes for Electrical Systems."
- H. Wiring Method for Smoke Control Systems: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems"
 - 1. Circuits and equipment control wiring associated with the Smoke Control system shall be installed in a dedicated raceway system.

- I. Wiring within Enclosures:
 - 1. Separate power-limited and non-power-limited conductors as recommended by manufacturer.
 - 2. Install conductors parallel with or at right angles to sides and back of the enclosure.
 - 3. Bundle, lace, and train conductors to terminal points with no excess.
 - 4. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks.
 - 5. Mark each terminal according to the system's wiring diagrams.
 - 6. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- J. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- K. Wiring to Remote Alarm Transmitting Device: Provide 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- L. Conductors: Size according to system manufacturer's written instructions, unless otherwise indicated.
- M. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- N. Optical Fiber Cable Installation:
 - 1. Comply with TIA/EIA-568-B.3.
 - 2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
- O. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.4 CONNECTIONS

- A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm-initiating connections to the following:
 - a. Atrium smoke-control system (smoke management) at firefighter smoke-control panel.
 - b. Elevator Recall system and components.
 - c. Emergency shutoffs for gas and fuel supplies.
 - d. Smoke dampers and combination Fire/Smoke dampers in air ducts of designated air-conditioning duct systems.
 - e. Air handling systems for shutdown control relay.
 - f. Horizontal Sliding Fire Doors; Accordion-Type Fire Doors; Fire Shutters; or Fire Curtains.
 - 2. Supervisory connections to the following:
 - a. Valve supervisory switches.
 - b. Low-air-pressure switch of each dry-pipe sprinkler system.
 - c. Elevator shunt trip breaker.
 - d. Fire-pump engine control panel, including power failure, dead-phase or phase-reversal condition.
- B. Where fire-protection systems are specified in Division 08 Section "Door Hardware" to be integral to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section and Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Paint junction box cover plates using red paint. Stencil the letters "FA" in white paint over red background.
 - 2. For all components of the fire alarm system requiring 120VAC power, provide a permanent engraved label at the component indicating the panel and circuit number from which it is fed.
- B. Install framed instructions in a location visible from fire-alarm control unit.
- C. Color-Coding:
 - 1. Color-code fire alarm conductors differently from the normal building power wiring.
 - 2. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits.
 - 3. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices.
- D. Provide a red marking on all circuit breakers feeding any fire alarm control system in accordance with NFPA 72. Provide a permanent engraved label next to the circuit breaker(s) feeding the system that reads "Fire Alarm Control Circuit".

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction, as required.
 - 1. Provide 14 days' advance notice of tests and opportunity for observation of tests by Engineer and Owner's representative.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
 - 3. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 5. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 7. Conduct Acceptance Testing per NFPA 92A (8.4) for Firefighters' Smoke-Control Station.
 - 8. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.
- B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

3.9 CLEANING

- A. Clean components according to manufacturer's written instructions.
- B. On completion of device box installation but before any wiring devices are installed, inspect interior of boxes and perform the following:
 - 1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- C. On completion of initiation and notification devices installation, inspect exterior surfaces and perform the following:
 - 1. Remove paint splatters and other spots.
 - 2. Remove all temporary markings and labels.
 - 3. Wipe down all devices with approve cleaning agent to remove fingerprints and dust.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's management and maintenance personnel to adjust, operate, and maintain fire-alarm system. Refer to Division 01 Section "Demonstration and Training."

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SECTION 283500

REFRIGERANT DETECTION AND ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes refrigerant monitors, notification appliances, and SCBA.

1.3 DEFINITIONS

- A. CMOS: Complementary metal-oxide semiconductor.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. MOS: Metal-oxide semiconductor.
- E. NDIR: Non-dispersive infrared.
- F. PIR: Photoacoustic infrared.
- G. SCBA: Self-contained breathing apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of refrigerant monitor, include refrigerant sensing range in ppm, temperature and humidity range, alarm outputs, display range, furnished specialties, installation requirements, and electric power requirement.
 - 2. For SCBA, include mounting details, service requirements, and compliance with authorized Federal agency.
- B. Shop Drawings:
 - 1. Air-Sampling Tubing: Size, routing, and termination including elevation above finished floor.
 - 2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Include machinery-room layout showing location of monitoring devices and air-sampling tubing with filter/inlet locations in relation to refrigerant equipment.
- B. Product Certificates: For monitoring devices and SCBA, signed by product manufacturer.
- C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant monitoring equipment and SCBA to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. One calibration kit including clean air calibration gas bottle for zero calibration and specific refrigerant calibration gas for span calibration, minimum 58-L capacity, pressure regulator, and tubing.

1.8 COORDINATION

- A. Coordinate refrigerant detection and alarm system with refrigerant contained in refrigeration equipment for compatibility.

PART 2 - PRODUCTS

2.1 [CMOS] [MOS] REFRIGERANT MONITOR

- A. Description: Sensor shall be factory tested, calibrated, and certified to continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, [shutting down fuel-fired equipment,]and automatically activating ventilation system.
- B. ASHRAE: Monitoring system shall comply with ASHRAE 15.
- C. Performance:
 - 1. Refrigerant to Be Monitored: [R-22] [R-134a] [R-407C] [R-410A].
 - 2. Range: 0 to 1000 ppm.
 - 3. Minimum Detectability: [50] <Insert value> ppm.
 - 4. Accuracy: Maximum 10 percent of full scale.
 - 5. Repeatability: Maximum plus or minus 2 percent of full scale.
 - 6. Response: Maximum 150 seconds for 90 percent of full scale, and 20-second step change.
 - 7. Detection Level Set Points:
 - a. Detection Level 1: [50] <Insert value> ppm.

- b. Detection Level 2: [250] <Insert value> ppm.
- 8. Operating Temperature: 32 to 104 deg F (0 to 40 deg C).
- 9. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.
- 10. Site Elevation: Maximum [6560 feet (2000 m)] <Insert elevation>.

D. Input/Output Features:

- 1. Maximum Power Input: 120-V ac, 60 Hz, 75 W.
- 2. Number of Sensor/Transmitter Points: [One] [Four] <Insert number>.
- 3. Alarm Relays: Minimum 3 relays at a minimum of 5-A resistive load each.
- 4. Alarm Set Points: Displayed and adjustable through keypad on front of meter.
- 5. Alarm Silence Switch: Mount in the front panel of the monitor to stop audible and visual notification appliances, but alarm LED remains illuminated.
- 6. Alarm Manual Reset: Momentary-contact push button in the front panel of the monitor stops audible and visual notification appliances, extinguishes alarm LED, and returns monitor to detection mode at current detection levels.
- 7. Display: Alphanumeric LCD, LED indicating lights for each detection level; acknowledge switch and test switch mounted on front panel; alarm status LEDs and service fault/trouble LEDs.
- 8. Audible Output: Minimum 75 dB at 10 feet (3 m).
- 9. Visible Output: Strobe light.
- 10. Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms.
- 11. Serial Output: RS-232 or RS-485[compatible with HVAC controls].
- 12. Enclosure: NEMA 250, [Type 1] [Type 12] <Insert type>, with locking quarter-turn latch and key.

2.2 NDIR REFRIGERANT MONITOR

- A. Description: Sensor shall be factory tested, calibrated, and certified to continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, [shutting down fuel-fired equipment,]and automatically activating ventilation system.
- B. ASHRAE: Monitoring system shall comply with ASHRAE 15.
- C. Performance:
 - 1. Refrigerant to Be Monitored: [R-22] [R-123] [R-134a] [R-407C] [R-410A].
 - 2. Range: 0 to 1000 ppm.
 - 3. Sensitivity:
 - a. Minimum Detectability: [10] <Insert value> ppm.
 - b. Accuracy: 0 to 100 ppm; plus or minus 10 ppm. 100 to 1000 ppm; plus or minus 10 percent of reading.
 - c. Repeatability: Plus or minus 1 percent of full scale.
 - d. Response: Maximum [10] <Insert value> seconds per sample.
 - e. Detection Level Set Points:
 - 1) Detection Level 1: [1] <Insert value> ppm.
 - 2) Detection [Level 2] [Level 1]: [10] [50] <Insert value> ppm.
 - 3) Detection [Level 3] [Level 2]: [50] [250] <Insert value> ppm.
 - 4. Sensitivity:

- a. Minimum Detectability: [20] <Insert value> ppm.
- b. Accuracy: 0 to 100 ppm; plus or minus 20 ppm, 100 to 1000 ppm; plus or minus 5 percent of reading.
- c. Repeatability: Plus or minus 1 percent of full scale.
- d. Response: 50 percent of a step change in 60 seconds.
- e. Detection Level Set Points:
 - 1) Detection Level 1: [20] <Insert value> ppm.
 - 2) Detection [Level 2] [Level 1]: [50] <Insert value> ppm.
 - 3) Detection [Level 3] [Level 2]: [250] <Insert value> ppm.
- 5. Operating Temperature: 32 to 104 deg F (0 to 40 deg C).
- 6. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.[Compensate sensor for relative humidity.]
- 7. Site Elevation: Maximum [6560 feet (2000 m)] <Insert elevation>.

D. Input/Output Features:

- 1. Maximum Power Input: 120-V ac, 60 Hz, 75 W.
- 2. Number of Air-Sampling Points: [One] [Four] [Eight] [16] <Insert number>.
- 3. Air-Sampling Point Inlet Filter: 0.10-micron filter element for each sampling point.
- 4. Air-Sampling Point Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms matched to sensor output.
- 5. Alarm Relays: Minimum [3] [4] relays at a minimum of 5-A resistive load each.
- 6. Alarm Set Points: Displayed on front of meter and adjustable through keypad on front of meter.
- 7. Alarm Acknowledge Switch: Mount in the front panel of the monitor to stop audible and visual notification appliances, but alarm LED remains illuminated.
- 8. Alarm Manual Reset: Momentary-contact push button in the front panel of the monitor stops audible and visual notification appliances, extinguishes alarm LED, and returns monitor to detection mode at current detection levels.
- 9. Display: Alphanumeric LCD, LED indicating lights for each detection level; acknowledge switch and test switch mounted on front panel; alarm status LEDs and service fault LEDs.
- 10. Audible Output: Minimum 75 dB at 10 feet (3 m).
- 11. Visible Output: Strobe light.
- 12. Sensor Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms.
- 13. Serial Output: RS-232 or RS-485[compatible with HVAC controls].
- 14. Enclosure: NEMA 250, [Type 1] [Type 12] <Insert type>, with locking quarter-turn latch and key.

2.3 PIR REFRIGERANT MONITOR

- A. Description: Sensor shall be factory tested, calibrated, and certified to continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, [shutting down fuel-fired equipment,]and automatically activating ventilation system.
- B. ASHRAE: Monitoring system shall comply with ASHRAE 15[and ASHRAE 147].
- C. Performance:
 - 1. Refrigerant to Be Monitored: [R-22] [R-123] [R-134a] [R-407C] [R-410A].
 - 2. Range: 0 to 1000 ppm.
 - 3. Sensitivity:

- a. Minimum Detectability: [1] <Insert value> ppm.
 - b. Accuracy: 0 to 50 ppm; plus or minus 1 ppm. 51 to 1000 ppm; plus or minus 10 percent of reading.
 - c. Repeatability: Plus or minus 1 percent of full scale.
 - d. Response: Maximum [10] <Insert value> seconds per sample.
 - e. Detection Level Set Points:
 - 1) Detection Level 1: [1] <Insert value> ppm.
 - 2) Detection [Level 2] [Level 1]: [10] [50] <Insert value> ppm.
 - 3) Detection [Level 3] [Level 2]: [50] [250] <Insert value> ppm.
4. Sensitivity:
- a. Minimum Detectability: [20] <Insert value> ppm.
 - b. Accuracy: 0 to 100 ppm; plus or minus 20 ppm, 100 to 1000 ppm; plus or minus 5 percent of reading.
 - c. Repeatability: Plus or minus 1 percent of full scale.
 - d. Response: 50 percent of a step change in 60 seconds.
 - e. Detection Level Set Points:
 - 1) Detection Level 1: [20] <Insert value> ppm.
 - 2) Detection [Level 2] [Level 1]: [50] <Insert value> ppm.
 - 3) Detection [Level 3] [Level 2]: [250] <Insert value> ppm.
- 5. Operating Temperature: 32 to 104 deg F (0 to 40 deg C).
 - 6. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range. Compensate sensor for relative humidity.
 - 7. Site Elevation: Maximum [6560 feet (2000 m)] <Insert elevation>.

D. Input/Output Features:

- 1. Maximum Power Input: 120-V ac, 60 Hz, 75 W.
- 2. Number of Air-Sampling Points: [One] [Four] [Eight] [16] <Insert number>.
- 3. Air-Sampling Point Inlet Filter: 0.10-micron filter element for each sampling point.
- 4. Air-Sampling Point Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms matched to sensor output.
- 5. Alarm Relays: Minimum [3] [4] relays at a minimum of 5-A resistive load each.
- 6. Alarm Set Points: Displayed and adjustable through keypad on front of meter.
- 7. Alarm Silence Switch: Mount in the front panel of the monitor to stop audible and visual notification appliances, but alarm LED remains illuminated.
- 8. Alarm Manual Reset: Momentary-contact push button in the front panel of the monitor stops audible and visual notification appliances, extinguishes alarm LED, and returns monitor to detection mode at current detection levels.
- 9. Display: Alphanumeric LCD, LED indicating lights for each detection level; acknowledge switch and test switch mounted on front panel; alarm status LEDs and service fault/trouble LEDs.
- 10. Audible Output: Minimum 75 dB at 10 feet (3 m).
- 11. Visible Output: Strobe light.
- 12. Sensor Analog Output: 0- to 10-V dc into 2k ohms, or 4- to 20-mA into 1k ohms.
- 13. Serial Output: RS-232 or RS-485[compatible with HVAC controls].
- 14. Enclosure: NEMA 250, [Type 1] [Type 12] <Insert type>, with locking quarter-turn latch and key.

2.4 MONITOR ALARM SEQUENCE

- A. Detection Level 1: Notify HVAC control workstation of detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Start ventilation system at low speed to allow occupancy by maintenance technicians to identify leaks. Cycle blue strobe lights.
- B. Detection [Level 2] [Level 1]: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Run ventilation system at high speed on a rise in concentration to this level, and change to low speed on a reduction in concentration below this level. Operate the ventilation system at high speed for a minimum of five minutes. Cycle amber strobe lights.
- C. Detection [Level 3] [Level 2]: Notify the HVAC control workstation of the detection in the refrigeration equipment room on a rise or fall of refrigerant concentration to this level. Sound alarm horns and cycle red strobe lights inside and outside refrigeration equipment room. Terminate operation of any combustion-process equipment located in the refrigeration equipment room. Provide manual reset for this detection level.
- D. Sensor Fault/Trouble: Notify HVAC control workstation of fault/trouble detection in monitor.

2.5 NOTIFICATION APPLIANCES

- A. Horns: Comply with UL 464; electric-vibrating-polarized type, listed by a qualified testing agency with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured **10 feet (3 m)** from the horn.
- B. Visible Alarm Devices: Comply with UL 1971; three color xenon strobe lights, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The words "REFRIGERANT DETECTION" printed in minimum **1/2-inch- (13-mm-)** high letters on the lens. Rated light output is [75] [110] <Insert number> candela.

2.6 AIR-SAMPLING TUBING

- A. Annealed-Temper Copper Tubing: **ASTM B 88, Type L (ASTM B 88M, Type B).**
- B. Polyethylene Tubing: ASTM D 2737, flame-retardant, nonmetallic tubing rated for ambient temperature range of **10 to 150 deg F (minus 13 to plus 65 deg C).**

2.7 SCBA

- A. Description: Open-circuit, pressure-demand, compressed-air SCBA; includes completely assembled, portable, self-contained devices designed for application in hazardous breathing environment. Tested and certified by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration according to 42 CFR 84, Subpart H.
- B. Face Piece: [Silicon] [EPDM] [Nitrile rubber] [Silicon, EPDM, or nitrile rubber], one-size-fits-all with double-sealing edge, stainless-steel speaking diaphragm and lens retainer, five adjustable straps to hold face piece to head (two straps on each side and one on top), exhalation valve in mask, close-fitting nose piece to ensure no CO₂ buildup, and perspiration drain to avoid skin irritation and prevent lens fogging.

- C. Backplate: Ergonomically designed of [glass fiber] [aluminum] [thermoset plastic] [glass fiber, aluminum, or thermoset plastic].
- D. Harness and Carrier Assembly: Large triangular back pad, with backplate and adjustable waist and shoulders straps. Modular design, detachable components, easy to clean and maintain. Shoulder straps are padded with flame-resistant material, reinforced with stainless-steel cable, and attached with T-nuts, washers, and screws.
- E. Air Cylinder, Regulator, and Pressure Gages: [30] [45] [60]-minute, low-pressure 2216-psig (15.3-MPa), [carbon-fiber composite] [fiberglass composite] [all-] [carbon-fiber composite, fiberglass composite, or all-] aluminum cylinders fitted with quick-fill assembly for refilling and air transfer. Two-stage regulator, and gage with end of service time whistle signal.
- F. Wall-Mounted Case: Watertight[, high visibility orange or yellow], corrosion-resistant, tough, lockable plastic case.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with ASHRAE 15[and ASHRAE 147].
- B. Install air-sampling inlets, or diffusion type monitors in pits, tunnels, or trenches in machinery room that are accessible to personnel.
- C. Floor mount diffusion-type monitor, sensor/transmitters, or air-sampling inlets on slotted channel frame 12 to 18 inches (300 to 450 mm) above the floor in a location near the refrigerant source or between the refrigerant source and the ventilation duct inlet.
- D. Wall mount air-sampling multiple-point monitors with top of unit 60 inches (1525 mm) above finished floor.
- E. Run air-sampling tubing from monitor to air-sampling point, in size as required by monitor manufacturer. Install tubing with maximum unsupported length of 36 inches (915 mm), for tubing exposed to view. Terminate air-sampling tubing at sampling point with filter recommended by monitor manufacturer.
- F. Install air-sampling tubing with sufficient slack and flexible connections to allow for vibration of tubing and movement of equipment.
- G. Purge air-sampling tubing with dry, oil-free compressed air before connecting to monitor.
- H. Number-code or color-code air-sampling tubing for future identification and service of air-sampling multiple-point monitors.
- I. Extend air-sampling tubing from exhaust part of multiple-point monitors to outside.
- J. Extend air-sampling tubing from outdoors to outdoor inlet connection of NDIR monitors. Terminate air-sampling tubing at outdoor inlet location with filter recommended by monitor manufacturer.
- K. Install warning signs, labels, and nameplates to identify detection devices and SCBA according to Section 230553 "Identification for HVAC Piping and Equipment."

- L. Place warning signs inside and outside each door to the refrigeration equipment room. Sample wording: "AUDIBLE AND VISUAL ALARM SOUNDING INDICATES REFRIGERANT DETECTION - ENTRY REQUIRES SCBA."
- M. Audible Alarm-Indicating Devices: Install at each entry door to refrigeration equipment room, and position not less than **6 inches (150 mm)** below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- N. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn at each entry door to refrigeration equipment room, and position at least **6 inches (150 mm)** below the ceiling.
- O. Mount primary[and secondary backup] SCBA on wall outside [each]interior door to refrigeration equipment room.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with requirements.
 - 2. Test and adjust controls and safeties.
 - 3. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- E. Repair or replace malfunctioning units and retest as specified above.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain refrigerant detection devices and SCBA equipment. Refer to requirements in Section 017900 "Demonstration and Training."
- B. SCBA Training: Provide an instructional video that details operating procedures of equipment.

END OF SECTION

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SECTION 311000
SITE PREPARATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not inclusive but listed as a guide, shall include:
 - 1. Furnishing of all labor, tools, equipment and incidentals required to complete the work.
 - 2. Layout of work.
 - 3. Protection of existing trees.
 - 4. Removal of trees and other vegetation.
 - 5. Topsoil stripping.
 - 6. Clearing and grubbing.
 - 7. General site excavation.
 - 8. Removing below-grade improvements.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Erosion Control - Section 312500

1.3 REFERENCES

Meet requirements and recommendations of applicable portions of Standard listed.

- A. ASTM D698 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 lb/ft²).
- B. ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- C. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, 2014, TxDOT.

1.4 SUBMITTALS

- A. Samples:
 - 1. Provide adequate samples for determination of moisture density relationships and Plasticity Index (P.I.) of on-site materials, imported fill material and drainage aggregate.
- B. Tests Reports: Submit complete laboratory analysis of soil material proposed for fill material.
 - 1. Establish moisture density relationship of in-place sub-grade in accordance with ASTM D-698.
 - 2. Establish moisture density relationship of proposed select fill(s) material in accordance with ASTM D-698.
 - 3. Perform PI test on proposed select fill material to confirm conformance with the project specifications in accordance with ASTM D-4318.
 - 4. Gradation of drainage aggregate in accordance with ASTM C-136.

1.5 JOB CONDITIONS

- A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets,

walk, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from the Owner.

- B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
- C. Protect improvements on adjoining properties and on Owner's property.

1.6 NOTIFICATION OF OWNERS OF UTILITY LINES AND EQUIPMENT

- A. Notify any corporation, company, individual or local authority owning conduits, wires, pipes or equipment on site that is affected by demolition work.
- B. Arrange for removal or relocation of indicated items and pay any fees or costs in conjunction with removal or relocation, except as otherwise noted.
- C. Cap lines in accordance with instructions of governing authorities or Owners.

1.7 EXPLOSIVES

Use of explosives is strictly prohibited.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Top Soil: Shall be rich, friable, sandy loam, free of lumps, debris, wood, roots, Nutgrass, Dallisgrass and reasonably free of other weeds and foreign grasses. Existing topsoil obtained by stripping and meeting the above requirements shall be stockpiled on site.
- B. Select Fill: Shall be select non-expansive sandy clay or clayey sand fill with a Plasticity Index (P.I.) of 4 to 12 and a Liquid Limit of 30% or less.
- C. Sand: Sand for wall backfill shall be pit run, free of organic matter, clays or other binders (concrete sand) with less than 10% passing the #200 mesh sieve.
- D. Non-select Fill: On-site clay material free of debris and vegetation processed so that clods or particles are a maximum of 2" in diameter.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that abandoned utilities have been properly disconnected and capped.
- B. Verify that required barricades and other protective measures are in place.

3.2 DEMOLITION OPERATIONS

- A. Execute demolition of designated existing site items.
- B. Materials, equipment and debris resulting from demolition operations shall become property of Contractor, unless otherwise noted. Immediately remove demolition debris from site and legally dispose.

3.3 SALVAGE

- A. Salvage designated site items for relocation and reinstallation.
- B. Store and protect items until ready for installation.

3.4 CLEARING AND GRUBBING

- A. The designated area shall be cleared of all trees, brush, shrubbery, plants, etc., not indicated on the plans to be preserved. Concrete shall be removed where indicated. Trees and brush designated to be left in place shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. Pruned limbs over two inches in diameter shall be treated by painting the exposed ends with an approved asphaltic material. Unless otherwise indicated on the plans, trees and stumps shall be cut off or otherwise removed as close to the natural ground as practicable on areas which are to be covered by at least three feet of embankment. On areas required for borrow sites and materials sources, stumps, roots, etc., shall be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used in construction.

3.5 GENERAL SITE EXCAVATION

- A. The term Building area shall mean the area generally within a line 5 feet from all exterior building wall lines and includes walks abutting the building or walks within the building area.
- B. The entire building and paving site shall be cleaned of all debris, vegetation, organic matter, concrete and asphalt paving to a depth of 4" minimum before excavation is begun.
- C. Perform the necessary cutting of the site to establish the grade indicated on the Grading Plan. Cutting shall be sufficiently deep to allow for fill materials to be placed on top of cut area with the finish top soil or paving material to attain the final finish grades.
- D. After acceptance of exposed cut surfaces by the Testing Laboratory, the exposed surface shall be proof-rolled. Soft, loose areas shall be removed to a level of stiff or dense soil. Backfill with acceptable select fill, moisture condition and compact as required by these specifications and the plans.
- E. Areas designated for planting or within the limit of construction not covered by building or pavements shall be held down 6" below finish grade for topsoil placement.
- F. General Demolition: Shall consist of removal and disposal of pavements and other obstructions visible at the ground surface, underground structures and utilities indicated to be demolished and removed. Remove all such excavated materials from site.
- G. Unauthorized Excavation: Consists of removal of materials beyond indicated subgrade elevations or dimensions without prior approval by engineer. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending the indicated bottom elevation of the footing or base to the excavation bottom, without altering required top elevation. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification.

3.6 BACKFILL AND FILL - GENERAL

- A. Surface Preparation for Fill: Scarify soil to a depth of 6", moisture condition the soil at optimum moisture. Compact to 95% of Standard Proctor at moisture contents at or above the Proctor optimum.

- B. Backfill and Fill: Place backfill and Select Fill materials in 6" loose lift. Before compaction, bring soil to optimum moisture. Compact each layer to required percentage of maximum density for each area of classification. Do not place backfill material on surfaces that are muddy or frozen.

3.7 GRADING

Uniformly grade all areas including adjacent transition areas and at all miscellaneous ground structures, curbs and walks, grade surrounding area uniformly to top of curb, walk or structure unless shown otherwise.

- A. Finish Grading: Grade area adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces to be free from irregular surface changes.
- B. Topsoil: Where areas are designated as planting, hold down subgrade 6". Fill with topsoil to required finish grade or to top of surrounding ground structure. Top soil shall be placed to a depth of 6", spread and hand raked to required finish grades. Top soil be placed over all fill areas, areas designated as planting and all areas not covered by building or pavement included in this contract. Coordinate topsoil placement and requirements with landscape work.

3.8 MAINTENANCE

- A. Protect newly graded areas from traffic and erosion and keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded and rutted areas to required finish elevations.
- C. When completed, compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape and compact to the required density prior to further construction.

3.9 DISPOSAL OF SPOILAGE AND CLEANOUT:

- A. All materials excavated or scheduled to be removed from the site, including, but not limited to concrete paving, asphalt paving, natural soils, abandoned utilities, rock, etc. shall be legally disposed off the site by the Contractor.
- D. During the course of the construction, the site shall be maintained free of excavated materials, spoilage, etc. and shall be kept clean and neat at all times.

END OF SECTION

SECTION 312000

EARTH MOVING

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Work included in this Section, while not at all inclusive but listed as a guide, shall include:
 - 1. Furnishing of all labor, tools, equipment and incidentals to complete the work.
 - 2. Layout of the work.
 - 3. All required excavation within the limits of the site.
 - 4. Removal, proper utilization or disposal of all excavated material.
 - 5. Shaping and finishing of all earthwork in conformity to the lines and grades as shown on the plans.
 - 6. Placement and compaction of all suitable material obtained from excavation, or other excavation on the site.
 - 7. Backfill for structures.

1.2 RELATED SECTION

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Erosion Control - Section 312500

1.3 REFERENCES

Meet requirements and recommendations of applicable portions of Standard listed.

- A. ASTM D698 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 lb/ft²).
- B. ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- C. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, 2014, TxDOT.

1.4 SUBMITTALS

- A. Samples: Provide adequate samples for determination of moisture density relationships and Plasticity Index (P.I.) of on-site materials, imported fill material and drainage aggregate.
- B. Safety Plan: When trench excavation exceeds a depth of five feet (5'), submit detailed plans and specifications for trench safety systems to meet the OSHA requirements necessary to satisfy federal and state laws and regulations. The trench safety plan shall be designed and sealed by a Registered Professional Engineer, licensed in the State Texas.
- C. Storm Water Pollution Prevention Plan: Prior to beginning the Earthwork, the Contractor shall develop and enforce a Storm Water Pollution Prevention Plan in accordance with the latest E.P.A. regulations. The Plan shall be prepared and sealed by a Registered Professional Engineer in the State of Texas. Submit five (5) copies of the Plan for the review.
- D. Test Reports: Submit complete laboratory analysis of soil material proposed for fill material.
 - 1. Establish moisture density relationship of in-place sub-grade in accordance with ASTM

- D-698.
2. Establish moisture density relationship of proposed select fill(s) material in accordance with ASTM D-698.
 3. Perform PI test on proposed select fill material to confirm conformance with the project specifications in accordance with ASTM D-4318.
 4. Gradation of Drainage Aggregate in accordance with ASTM C-136.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Top Soil: Shall be rich, friable, sandy loam, free of lumps, debris, wood, roots, Nutgrass, Dallisgrass and reasonably free of other weeds and foreign grasses. Existing topsoil obtained by stripping and meeting the above requirements shall be stockpiled on site.
- B. Select Fill: Shall be select non-expansive sandy clay or clayey sand fill with a Plasticity Index (P.I.) of 4 to 12 and a Liquid Limit of 30% or less.
- C. Sand: Sand for wall backfill shall be pit run, free of organic matter, clays or other binders (concrete sand) with less than 10% passing the #200 mesh sieve.
- D. Non-select Fill: On-site clay material free of debris and vegetation processed so that clods or particles are a maximum of 2" in diameter.

2.2 ACCESSORIES

- A. Drainage Fabric:
 1. Mirafi Filter Fabric(O.A.E.), ASTM D4491.

2.3 ON SITE ROCK

- A. Rock Excavated on-site may be utilized as embankment, backfill, subgrade and base material provided it meets the following usage requirements.
 1. Embankment: The maximum dimension of any rock, clod or lump shall be less than the depth of the embankment layer, and in no case shall any rock over two (2) feet in its maximum dimension be placed in an embankment. Any over-sized rock, which is otherwise acceptable material, may be broken to the required dimension and utilized in embankment construction.
 2. Backfill: See Section 312334 - Excavation and Backfill for Conduits.

2.4 BORROW

This material shall consist of suitable earth material, other than rock, such as loam clay, or other such materials approved by engineer that will form a stable embankment.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Construction Methods: The Contractor shall abide by all applicable federal, state and/or local laws governing excavation work. All excavation shall be in accordance with the lines, grades and typical sections as shown on the plans. Unless otherwise shown on the plans, excavation shall be made to the subgrade. Where excavation terminates in unstable soil, the Contractor shall remove the unstable soil and backfill to the required grade.
Where excavation terminates in loose or solid rock, the Contractor may be required to extend

the depth of excavation six inches and to backfill with select material compacted as required.

- B. Provisions for Drainage: If it is necessary in the execution of the work to interrupt the natural drainage of the surface, or the flow of artificial drains, the Contractor shall provide temporary drainage facilities that shall prevent damage to public or private interest and shall restore the original drains as soon as the work shall permit. The Contractor shall be held liable for all damages which may result from neglect to provide for either natural or artificial drainage which his work may have interrupted.
- C. Excess Excavation: Excavation in excess of that needed for construction shall be disposed of by the Contractor at no additional cost to the Owner. In general, excess excavation shall be used in widening of embankments, flattening of slopes, etc. but, if it becomes necessary to waste any material, it shall be disposed of in such a manner as to present a neat appearance and to not obstruct proper drainage or cause injury to any improvements or abutting property.

3.2 EMBANKMENT

- A. Construction Methods: Prior to the placing of any embankment, all clearing and grubbing and site preparation shall have been completed. Stump holes or other small excavations within the limits of the embankment shall have been backfilled before commencing the subgrade construction. The surface of the ground, including plowed or loosened ground or small ditches or washers, shall be restored to approximately its original slope.
 - 1. The surface of hillsides shall be loosened by the scarifying or plowing to a depth of not less than four inches, or cut into steps before embankment materials are placed. The embankment shall then be placed in layers as hereinafter specified, beginning at the low side in part widths as the embankment is raised. The material which has been loosened shall be re-compacted simultaneously with embankment material placed at the same elevation. Where embankment is to be placed over or adjacent to existing embankments, the slopes shall be plowed or scarified to a depth not less than four inches and the embankment built up in successive layers, as hereinafter specified, to the level of the old embankment before its height is increased. Then, the old embankment shall be scarified and re-compacted with the next layer of embankment. The total depth of the scarified and added materials shall not exceed the permissible depth of the layer.
 - 2. All embankments for road beds or pavements shall be constructed in layers approximately parallel to the finished grade of the street and shall be so constructed as nearly as possible to conform to the cross section of the subgrade section. Embankments shall be constructed to the established grade and to the shape of the typical section shown on the plans, and each section shall conform to the detailed sections of slopes. After completion of the embankment, it shall be continuously maintained to its finished section and grade until the project is accepted.
 - 3. Earth embankments shall be constructed in successive layers, for the full width of specified depth or cross sections; and in such length as are suitable for the sprinkling and compaction methods to be used. Each layer of earth embankment shall be uniform as to material, density, and moisture content before beginning compaction. Prior to compaction, the layers shall not exceed six inches in depth for pneumatic tire rolling or eight inches in depth for rolling with other types of rollers.
 - 4. Earth embankment placed adjacent to and over pipes, culverts, and other structures shall be of suitable material and shall be placed in successive layers approximately horizontal. Layers of embankment shall be brought up uniformly on each side of the structure, and special care shall be taken to prevent any wedging action against the structure. For such distances along embankments adjacent to structures where it is impracticable to obtain compaction by rolling, the embankment material shall be placed in layers not exceeding six inches in depth of loose material wetted uniformly to the moisture content just above optimum; and shall then be compacted by mechanical hand compactors or other approved methods, maintaining the required moisture content by additional sprinkling, if

necessary, supplemented by such hand work as is necessary to secure a uniform and thoroughly compacted fill, until each layer has been uniformly compacted.

5. All earth, cuts, full of part width in the side of a hill, which are not required to be excavated below subgrade elevation for base or backfill, shall be scarified to a uniform depth of not less than six inches below grade shown on the plans; and the materials shall be mixed and reshaped by blading and then sprinkled and rolled in accordance with the hereinabove outlined requirements for earth embankments.

- B. Density Testing: For each layer of earth embankment and select material, the relative compaction of the embankment shall be as shown on the plans. After each section of earth embankment or select material is completed, moisture-density tests shall be made as follows:

Paved Areas/Structural Foundations - one test per 2000 sf.
Sidewalk and grassed areas - one test per 3000 sf.

3.3 BACKFILL FOR STRUCTURES

- A. Preparation:
 1. Prior to backfilling below grade walls, verify that preceding work has been satisfactory completed, including membrane waterproofing and sub-soil drainage system.
 2. Verify that forms, trash, debris and any temporary shoring has been removed.
 3. Verify that basements walls or other earth retaining walls shown on the plans are supported as required on the structural drawings.
- B. Grade Beams: Backfill with select fill. Place backfill in layers not exceeding 8" loose depth, compact to density specified elsewhere.
- C. Basement Walls: Backfill with select fill and as noted in sections and details on the drawings. Extend backfill to within 2 feet of established rough grade. Place backfill in layers not exceeding 8" loose depth and compact to 95% Standard Proctor. Backfill final one foot with approved clay material.
 1. When planting is scheduled adjacent to building, hold top of clay fill down to depth required for placement of top soil.
 2. When pavement is scheduled adjacent to wall, backfill with select fill and carry it to the required sub-grade elevation required for pavements.

3.4 SUBGRADE PREPARATION FOR PAVEMENTS

- A. Scarify existing soil prior to placing any fill material, or providing soil stabilization. Compact in-place material to a minimum of 95% Standard Proctor density.
- B. Place fill material (or stabilized soil) in 6" loose lifts, compact each lift to 95% Standard Proctor density.

3.5 GRADING

Uniformly grade all areas including adjacent transition areas and at all miscellaneous ground structures, curbs and walks, grade surrounding area uniformly to top of curb, walk or structure unless shown otherwise.

- A. Finish Grading: Grade area adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces to be free from irregular surface changes.
- B. Topsoil: Where area are designated as planting, hold down subgrade 6". Fill with topsoil required finish grade or to top of surrounding ground structures. Top soil shall be placed to a

depth of 6", spread and hand raked to required finish grades. Top soil shall be placed over all fill areas, areas designated as planting and all areas not covered by building or pavement included in this contract. Coordinate topsoil placement and requirements with landscape work.

END OF SECTION

SECTION 312313

SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not all inclusive but listed as a guide shall include.
 - 1. Furnishing of all labor, tools, equipment and incidentals to complete the work.
 - 2. Layout of the work.
 - 3. All required excavation within the limits of the work area.
 - 4. Removal, proper utilization or disposal of all excavated material.
 - 5. Compacting, shaping and finishing of all subgrade in conformity to the alignment, cross section, and elevation shown on the plans.
 - 6. Sprinkling for dust control.
- B. Submit complete laboratory analysis of soil material proposed for fill material.
 - 1. Establish moisture density relationship of in-place sub-grade in accordance with ASTM D-698.
 - 2. Establish moisture density relationship of proposed select fill(s) material in accordance with ASTM D-698.
 - 3. Perform PI test on proposed select fill material to confirm conformance with the project specifications in accordance with ASTM D-4318.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Earthwork – Section 312315
 - 2. Excavation and Backfill for Conduits – Section 312334

1.3 REFERENCES

Meet requirements and recommendations of applicable portions of Standards listed.

- A. ASTM D698 - Laboratory Compaction Characteristic of Soil Using Standard Effort (12,400 lb/ft;).
- B. ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- C. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, 2014, TxDOT.

PART 2 - PRODUCTS n/a

PART 3 - EXECUTION

- 3.1 **GENERAL:** After the excavation or embankment has been substantially completed, the subgrade shall be brought to the proper alignment, cross-section and elevation, so that after rolling and subsequent finishing operations, it shall conform to the correct configuration and dimensions as indicated on plans.

- 3.2 EQUIPMENT: All equipment necessary for the construction of this item shall be suitable for the work considering the confined work area and shall be approved by the **engineer** as to condition before the contractor shall be permitted to begin construction operations on which the equipment is to be used. Hand operated mechanical tampers may be used.
- 3.3 COMPACTION: Compaction shall consist of the equipment operation, as herein specified discretion.
- A. Compaction Methods: The method of compaction shall be left to the discretion of the contractor. Each layer of fill, if dry, shall be wetted uniformly to the moisture content required to obtain the desired density and shall be compacted by means of tamps or rammers.
- 3.4 FINISHED SUBGRADE: After completion of the compaction and immediately ahead of the application of pavement, the subgrade shall then be tested with templates or string lines by the Contractor. All irregularities which develop in excess of one-half inch in a length of 16 feet (12.5 mm in 5M) measured longitudinally shall be corrected by loosening, adding or removing material; reshaping; and recompacting by sprinkling and rolling. The completed subgrade shall have a uniform density of not less than of the maximum density, as shown on the plans, determined by ASTM D 698. Moisture content shall be within minus 2 to plus 4 of optimum.
- The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required pavement section and established grade, until the pavement is placed, and shall be kept wetted down sufficiently in advance of placing any pavement to ensure its being in a firm and moist condition for at least two inches below surface of the prepared subgrade. Only such subgrade as is necessary for the satisfactory prosecution of the work shall be completed ahead of the placement of pavement. Complete drainage of the subgrade shall be provided at all times.
- 3.5 SPRINKLING FOR DUST CONTROL: Sprinkling for dust control shall consist of the authorized application of water on those portions of the projects as shown on the plans or as directed and herein specified.
- The Contractor shall operate a sprinkler which shall insure the distribution of water in a uniform and controllable rate of application. It shall be the Contractor's continuous responsibility at all times including nights, holidays, weekends, etc., until acceptance of the project by the owner, to maintain the project free of dust in a manner which shall cause the least inconvenience to the public.
- 3.6 COMPACTION TESTS: The completed subgrade shall be tested for compaction and moisture content at the rate of one test per 10,000 square foot.

END OF SECTION

SECTION 312334

EXCAVATION AND BACKFILL FOR CONDUITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not all inclusive but listed as a guide, shall include:
 - 1. Furnishing of all labor, tools, equipment, materials and incidentals to complete the work.
 - 2. Layout of work.
 - 3. Excavation and backfill for underground pipes and conduits.
 - 4. Trench safety.
 - 5. Testing.
 - 6. Clean up.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the work as necessary to maintain satisfactory progress of the Work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Storm Sewer Line Installation - Section 334100

1.3 REFERENCES

Meet requirements and recommendations of applicable portions of the Standards listed.

- A. ASTM C33 - Concrete Aggregates.
- B. ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- C. ASTM D698 - Laboratory Compaction Characteristics of Soil Using Standard Effort.
- D. American Society of Testing and Materials, ASTM.
- E. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, TxDOT 2014.

1.4 SUBMITTALS

- A. Samples:
 - 1. Provide adequate samples for determination of moisture density relationship and Plasticity Index (P.I.) of on-site materials, imported fill material and drainage aggregate.
- B. Trench Excavation Protection shall be as required by the provisions of Part 1926, Subpart P - Excavations, trenching, and shoring of the Occupational Safety and Health Administrations Standards and Interpretations. Additional information may be obtained from the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), 525 Griffin Square Building, Room 602, Dallas, Texas 75202, (214) 767-4731.
- C. Furnish and pay for services of Professional Engineer registered in the State of Texas to prepare detailed plans and specifications for trenching and excavation safety systems to meet the requirements of OSHA and Federal, City, and State Law and regulations. Such documents when prepared shall be separately issued by the Contractor to be included within the

- D. Submit one copy of the trench and safety documents to the Owner.

PART 2 - PRODUCTS

2.1 PIPE BEDDING MATERIAL FOR STORM SEWERS

- A. General: The pipe shall be bedded in accordance with details shown on the plans for the type of bedding indicated or specified.
- B. Gravel:
1. Screened Pit Gravel: Passing 1 inch sieve and retained on 5/8 inch sieve.
 2. Pea Gravel: Passing 5/8 inch sieve and retained on 1/8 inch sieve.
 3. The aggregate used shall contain not more than a total of eight percent by weight of deleterious substances such as clay, shale or organic matter.

2.2 PIPE BEDDING MATERIAL FOR WATER AND SANITARY SEWER MAINS

- A. Crushed Stone Embedment:
1. Description: The aggregate shall consist of durable particles of crushed stone; free from frozen material or injurious amount of salt, alkali, vegetable matter or other material either free or as adherent coating; and its quality shall be reasonably uniform throughout. It shall have a wear of not more than 40 percent when tested in accordance with Texas TxDOT Test Method Tex-410-A.
 2. Test: When tested by standard laboratory methods, crushed rock embedment for each gradation shall meet the following requirements for percentage by weight.

	<u>PERCENT</u>
Retained on 1-1/2 inch sieve	0%
Retained on 1 inch sieve	0-5%
Retained on 2 inch sieve	40-75%
Retained on No. 4 sieve	90-100%
Retained on No. 8 sieve	95-100%

Fine Crushed Rock - Aggregate Grade 8

	<u>PERCENT</u>
Retained on 2 inch sieve	0%
Retained on 3/8 inch sieve	0-5%
Retained on No. 4 sieve	35-60%
Retained on No. 8 sieve	90-100%

<u>Coarse Crushed Rock</u>	<u>PERCENT</u>
Passing 1-1/2 inch sieve	100%
Retained on 3/4 inch sieve	100%

- B. Granular Material: Granular material shall be free flowing, such as sand or hydraulically graded crushed stone fines, or mixed sand and gravel, or sandy loam. The material shall be free from lumps, stones over two inches in diameter, clay and organic matter.
- C. Select Material: Select material shall be gravel, fine rock cuttings sand, sandy loam or loam free from excessive clay. Rock cuttings shall have no dimension greater than two inches.

- D. Natural Gravel: Natural gravel shall consist of uncrushed stones meeting the requirements for wear as outlined in Item 2.2A. The material shall be washed and screeded and not have by weight more than one percent organic matter, clays or loam are not more than five percent by weight of anyone of or combination of slate, shale, schist or soft particles of sandstone. The graduation shall be:

	<u>PERCENT</u>
Passing 1-1/2 inch sieve	100%
Retained on 3/4 inch sieve	100%

- E. Sand: Sand shall consist of clean, hard, durable, uncoated grains, free from lumps and organic material. All particles must pass a No. 8 sieve.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. General: In general, all excavation shall be made in open cut from the surface of the ground and shall be no greater in width or depth than is necessary to permit the proper construction of the work in accordance with the plans and these specifications. All excavation shall be to the line and grade shown on the plans. The entire foundation area in the bottom of all excavation shall be firm, stable, and at uniform density as nearly as practicable. Unless necessary, materials shall not be disturbed. The final cleaning off and preparing of the foundation area shall be done immediately prior to the placing of the conduit or structures.

1. Trench Bottom Elevation. All trenches for installation of water, storm sewer and/or sanitary sewer lines shall be excavated to a point below the barrel of the pipe for the type of embedment specified.
2. Trench Overcut. Should the Contractor excavate below the plan trench bottom for water or sewer lines, he shall backfill to trench bottom grade shown on the plan with approved aggregate, consolidated and compacted. If the Contractor elects to overcut the trench and use gravel and drain pipe as an underdrain in lieu of or in conjunction with pumping, draining or well pointing, the additional work shall be considered as incidental work; and additional compensation shall not be allowed.

Where the character of the foundation material is such that a proper foundation cannot be prepared at the elevation shown on the plans, the Contractor shall deepen the excavation to where a proper foundation can be prepared. Such material removed shall be replaced with foundation materials and thoroughly compacted in place to the finished grade elevation.

3. Excess Trench Width. When the following maximum trench widths are not maintained to a point of one foot above the top of the pipe, the Contractor shall provide at his expense the next higher class of embedment; or embedment as directed by the Owner which shall provide adequate support.

a) Width of Trench. The limiting trench width shall be as follow:

- 1) For 24-inch pipe and smaller, the trench width shall be taken as 24 inches or O.D. of the pipe plus 16 inches whichever is greater.
- 2) For pipe larger than 24 inch size, but not to exceed 72-inch, the trench width shall be taken as equal to the O.D. of the pipe installed plus 24 inches.
- 3) For pipe larger than 72-inch (1.8M) size, the trench width shall be taken as equal to the O.D. times plus 1.25 plus 1 ft.
- 4) Progress: The Owner shall have the right to limit the amount of trenches that shall be opened, or partly opened, in advance of or following the pipe laying operation. Unless otherwise directed by the Owner, the completion of backfill shall immediately follow the pipe laying. In the event the

Contractor fails to comply with this requirements, the Owner may stop the pipe laying until the requirements are met.

- B. Excavation Classifications: All excavation is unclassified and involves removal of all materials necessary to permit carrying on the completion of the work. Bidders must satisfy themselves as to the actual existing subsurfaces conditions, including but not limited to the depth, location and sizes of pipe or conduits of various kinds in place.
- C. Existing Utilities: The Contractor shall thoroughly familiarize himself with available information regarding existing on-site utilities. He shall uncover critical points prior to beginning any trench excavation. Changes to the drawings due to conflicts with existing utilities require the prior approval of the Owners Representative.
- D. Work Sequence: The Contractor shall schedule his work so that all utilities are fully operational. Maintaining acceptable clearance between utilities will be the responsibility of the Contractor.

3.2 SHORING AND SHEETING

When necessary to prevent caving or unduly hazardous working conditions, or to comply with existing laws, trench walls shall be appropriately braced; or sheeted and braced. Where bracing or sheeting and bracing are used, the trench width shall be increased accordingly, shall be considered as incidental work; and shall not be paid for as a separate item. In wet, saturated or flowing materials where it is necessary to install tight sheeting or cofferdams, wood or steel sheet piling shall be used. All sheeting, shoring and bracing shall have strength and rigidity to withstand the pressure exerted; to maintain the side of the excavation properly in place; and to protect all persons or property from injury or damage. When excavations are made adjacent to existing buildings or other structures, or in paved streets, particular care shall be taken to adequately sheet, shore and brace the sides of the excavation to prevent undermining of, or settlement beneath the structures or pavement. Underpinning of adjacent structures or pavement has become necessary it shall be removed, the void satisfactorily refilled, compacted and the pavement replaced. Wooden sheeting, shoring and bracing shall be left in place where it is adjacent to the pipe embedment for the initial lift of backfill. The removal of all sheeting, shoring and bracing shall be done in such manner as not to endanger or damage either new or existing structures, private or public properties; and so as to avoid cave-ins, or sliding of the banks. All holes or voids left by the removal of the sheeting, shoring or bracing shall be immediately and completely filled and compacted with suitable materials. If, for any reason, the Contractor elects to leave in place the sheeting, shoring or bracing, no payment shall be allowed for such material left in place.

- A. Disposal of excavated materials: Suitable excavated materials may be piled adjacent to the work to be used for backfilling. Excavated materials unsuitable for backfilling, or in excess of that required for backfilling, shall be disposed of. Desirable topsoil, sod, etc., shall be carefully removed and piled separately adjacent to the work when required. Excavated materials shall be handled at all times in such manner as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the lie of the work. The excavated material in rock which is not suitable material for bedding or backfill shall be disposed of. Suitable selected bedding or backfill material shall be provided at no additional cost to the Owner. The contractor shall indemnify and hold harmless the Owner and all of his officers, agents and employees from all suits, actions or claims of any character resulting from his arrangements for and disposal of soil.
- B. Dewatering: The Contractor shall remove all water from any source which may accumulate in the excavation. The embedment or pipe shall not be installed in water. No water shall be allowed to flow through or over unset concrete or through the completed line. All water removed from excavations shall be disposed of in an approved manner, so as not to create

unsanitary conditions; nor to cause injury to persons or property; nor damage to the work in progress, and/or not to interfere unduly with the use of streets, private driveways or entrances. Pumping, bailing and draining, underdrains, ditches, etc., shall be considered as incidental work and shall not be paid for as separate items.

3.3 BACKFILL

- A. Backfill Procedure: Backfill procedure is that procedure required to return trenches or excavated areas to a satisfactory condition. Such backfilling occurs in two general areas: They are:

1. Areas not subject to vehicular traffic:
and
2. Areas subjected directly to, or influenced by, vehicular traffic.

The methods of backfilling to be used shall vary with the width of trench, the character of the materials excavated, the method of excavation, the type of conduit and the degree of compaction required. The placing of backfill shall not begin until the pipe structure has been properly bedded and jointed. The excavation shall be backfilled only with approved material. Backfill is divided into two major categories:

1. Embedment is the material upon which the pipe rests; and which covers sewer and water lines.
2. Trench backfill material is the material required to fill the trench from the top of the embedment to ground elevation or subgrade or a street.

- B. Compaction: Compaction of all backfill material shall be performed in a manner that shall not crack, crush and/or cause the installed pipe to be moved from the established grade and/or alignment, as shown on the plans. Satisfactory density shall be obtained at various depths on all backfill material as indicated from random selected test points prior to the required exfiltration or pressure tests that are to be performed on lines being constructed. The required densities shall be at not less than the optimum moisture of the material.

1. Densities - areas subjected to or influenced by vehicular traffic. The trench backfill shall be mechanically compacted to the top of the subgrade in six-inch lifts to at least 95 percent of maximum density as determined by ASTM D698. Moisture content shall be within minus 2 to plus 4 of optimum. The embedment shall be compacted to a density as specified under the description of the embedment required.
2. Densities - areas not subjected to or influenced by vehicular traffic. The trench backfill shall be placed in layers into more than 10 inches in depth (loose measurement) and shall be compacted by whatever means the Contractor chooses, to a density comparable with the adjacent undisturbed material. The embedment shall be compacted to a density as specified under the description of the embedment required.
3. Special situations. In areas specifically designated in the plans and specifications, the entire backfill shall be backfilled and compacted to the density specified.
4. Limitations. Densities as specified shall be obtained as the project progresses. No more than 75 percent of the pipe installation on the project is to be completed until specified compaction and density requirements have been ascertained on backfill material for at least 25 percent of the pipe laid.
5. Compaction methods. The method of compaction shall be left to the discretion of the Contractor with the following exception, unless otherwise specified, provided the degree of compaction is obtained and provided that the pipe is not damaged in the process. Compaction of any backfill material by flooding or jetting shall not be permitted. Hand-operated mechanical tampers may be used.
6. Embedment. The type of embedment to be used for storm sewers, sanitary sewers or water mains shall be as on the plans.

3.4 DISPOSAL OF EXCESS MATERIAL:

- A. Excess Excavated Material (soil material free of trees, stumps, logs, brush, roots, rubbish and other objectionable matter which has been accepted by the Owner): Remove excess excavated material from the construction site before Pre-final Inspection. Approved excess material shall be deposited on the Owners property outside the perimeter road as indicated by the Drawings or as directed by the Owner.
- B. Waste Material (soil material including trees, stumps, logs, brush, roots, rubbish and other objectionable matter which has not been accepted by the Owner): Remove waste material from the project site before Pre-final Inspection. Legally dispose of material at a licensed site or with written and notarized permission from the property owner for a private disposal site. All costs associated with waste material removal and disposal shall be paid for by the Contractor.

3.5 TESTING

- A. Laboratory Testing and Inspection Services: As specified in Section 014600 - Testing Laboratory Services.

END OF SECTION

SECTION 312500
EROSION CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not inclusive but listed as a guide, shall include:
 - 1. Furnishing of all labor, tools, equipment and incidentals required to complete the work.
 - 2. Layout of work.
 - 3. Installation of mulch berm.
 - 4. Placement of riprap.
 - 5. Erosion Control matting.
 - 6. Clean-up.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the Work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Site Clearing - Section 311000
 - 2. Earth Moving – Section 312000

1.3 REFERENCES

Meet requirements and recommendations of applicable portions of Standards listed.

- A. ASTM D698 - Laboratory Compaction Characteristic of Soil Using Standard Effort (12,400 lb/ft;).
- B. ASTM D4318 - Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- C. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, 2014, TxDOT.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions and Section 013300
- B. Product data for drainage piping specialties.
- C. Product data for geotextiles and erosion control matting.
- D. Product data for soil retention blankets.
- E. Product data for compost mulch.

1.5 SUMMARY

- A. This work shall consist of furnishing, installing, maintaining, and removing devices to prevent silt leaving the site, either thru inlets or by overland flow around inlets. The quantities of temporary silt fence shown on the plans may be increased or decreased based on weather, construction procedures, and actual site conditions that occurs during construction of the

project. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

PART 2 – PRODUCTS

2.1 GEOTEXTILES

- A. This specification provides criteria for wire-supported geotextile silt fence as well as a self-supporting geotextile silt fence.
- B. Fibers used in the manufacture of geotextiles shall consist of long-chain synthetic polymers, composed of at least 85% by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such as that the filaments or yarns retain dimensional stability relative to each other, including selvages. The geotextile shall be specific for its intended purpose. The geotextile shall be free from any treatments or coating which might adversely alter its physical properties after installation.
- C. Geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements.
- D. Posts: Either wood, steel, or synthetic posts may be used. Posts shall have a minimum length of 36 in. plus burial depth and be of sufficient strength to resist damage during installation and to support applied loads.
- E. Support Fence: Wire or other support fences shall be at least 32 in. high and strong enough to support applied loads.
- F. Prefabricated Fence: Prefabricated fence systems may be used provided they meet all of the above material requirements.

2.2 GEOTEXTILES

- A. This specification provides criteria for geotextiles used in erosion control devices other than silt fence.
- B. Fibers used in the manufacture of geotextiles shall consist of long-chain synthetic polymers, composed of at least 85% by weight polyolefins, polyesters, or polyamide. They shall be formed into a network such as that the filaments or yarns retain dimensional stability relative to each other, including selvages. The geotextile shall be specific for its intended purpose. The geotextile shall be free from any treatments or coating which might adversely alter its physical properties after installation.
- C. Geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements.

2.3 SOIL RETENTION BLANKET

- A. Short Term Protection:
 - 1. Description. This item shall govern for providing and placing wood, straw or coconut fiber mat, synthetic mat, paper mat, jute mesh or other material as a soil retention blanket for

erosion control on slopes or ditches for short term protection or seeded or sodded areas as shown on the plans..

2. Soil Retention Blankets. Samples of all soil retention blankets shall be submitted to the Architect prior to use. A current list of qualified materials may be obtained by writing to the Director of Maintenance and Operations, Texas Department of Transportation, 125 E. 11th Street, Austin, Texas 78701-2483. Materials shall be approved by the Architect.

B. Long Term Protection.

Geotextiles.

1. General. Geotextiles are woven or non-woven synthetic fabrics which are designed to be used for erosion control and soil stabilization applications.
2. Geotextiles used in Erosion Control and Stabilization Applications: The fabric conform to the following average roll minimum values (lot mean-2 standard deviations), as determined by Federal Highway Administration Task Force 25 guidelines cited below, measured in the weakest direction:

Designation	Topic	Erosion			Stabilization			
		PR	UPR		LOADING			
					Low	Med.	Hi	VHI
ASTM D 4632	Grab Strength(lbs)	90	200		90	130	180	27
ASTM D 4632	Grab Elongation	15%	15%		NA	NA	NA	NA
ASTM D 4533	Trapezoidal Tear(lbs)	30	50		30	40	50	75
ASTM D 751	Burst (psi)	140	320	145	210	290	430	
ASTM D 751	Puncture (psi)	40	80		30	40	75	110
ASTM D 4751	Equivalent Opening Size (EOS) (mm)-soil retention							

For Soils in Which:

50% or less passes a #200 mesh sieve
 More than 50% passes a #20 mesh sieve
 ASTM D 4491 Permeability (k)

EOS:

Greater than a #30 sieve
 Greater than a #50 sieve

Type of Application

Critical/Severe:
 Normal Applications:

Required Permeability

k (fabric) > 10k (soil)
 k (fabric) > k (soil)

*PR: Protected Application (used in conjunction with a buffer)

UPR: Unprotected Application (used with no protective buffer)

3. Fasteners. Fasteners shall conform to the manufacturer's recommendations.

2.4 NOT USED

2.5 TOPSOIL

The topsoil shall be fertile soil, be easily cultivated, be free from objectionable material, have relatively high erosion resistance and be readily able to support the growth of planting, seeding or sodding.

2.6 SOD

The sod shall consist of live, growing Bermuda grass, Buffalo grass, St. Augustine grass where

shown on the plans, or other acceptable grass secured from sources which are approved by the Architect. Bermuda grass sod, St. Augustine grass sod, or other grasses as shown on the plans, shall have a healthy virile root system of dense, thickly matted roots throughout the soil of the sod for a minimum thickness of 1 inch. The Contractor shall not use sod from areas where the grass is thinned out, nor where the grass roots have been dried out by exposure to the air and sun to such an extent as to damage its ability to grow when transplanted.

2.7 FERTILIZER

- A. Specification Submittal. Submit a sample label or specification of the fertilizer proposed to be used for the Owners approval.
 - 1. General: Fertilizer shall be a commercial product, uniform in composition, free flowing and suitable for application with approved equipment. Fertilizer shall be delivered to the site in fully labeled original containers. Fertilizer which has been exposed to high humidity and moisture, has become caked or otherwise damaged, making it unsuitable for use, shall be rejected.
 - 2. Initial Planting Application. Fertilizer for the initial planting application shall be of an organic base containing by weight the following (or other approved) percentages of nutrients: 15-10-5 (N-P-K); also containing 1-15 percent sulphate and traces of iron and zinc as required and approved by the Owner.
 - 3. Post Planting Application. Fertilizer for the post planting application shall be a chemical base fertilizer containing by weight the following percentages of nutrients: 21-0-0 (N-P-K) ammonium sulphate; or the nitrogen equivalent of 33-0-0 ammonium nitrate.

PART 3 - EXECUTION

3.1 MULCH BERMS

- A. The Contractor shall install a mulch berm as shown on the plans, and at other locations as required. Fence construction shall be adequate to handle the stress from sediment loading.
- B. It is the Contractors responsibility to maintain the integrity of mulch berms as long as they are necessary to contain sediment runoff. The Contractor shall inspect all mulch berms after each rainfall and at least daily during prolonged rainfall. Any deficiencies shall be immediately corrected by the Contractor. In addition, the Contractor shall make a daily review of the location of the mulch berms in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional mulch berms shall be installed. Should the mulch berm become damaged or otherwise ineffective while the barrier is still necessary, it shall be repaired promptly.
- C. Sediment deposits shall either be removed when the deposit reaches approximately one-half of the height of the mulch berm or a second mulch berm shall be installed.

The mulch berm shall remain in place as long as needed. Upon removal, the Contractor shall remove and dispose of any excess silt accumulations, dress the area to give a pleasing appearance, and vegetate all bare areas the berm materials will remain the property of the Contractor and may be used at other locations provided the materials meet their intended purpose.
- D. The designated area shall be cleared of all trees, brush, shrubbery, plants, etc., not indicated on the plans to be preserved. Concrete shall be removed where indicated. Trees and brush designated to be left in place shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. Pruned limbs over two inches in diameter shall be treated by painting the exposed ends with an approved asphaltic material. Unless otherwise indicated on the plans, trees and stumps shall be cut off or otherwise removed as close to the natural ground as practicable on areas which are to be covered by at

least three feet of embankment. On areas required for borrow sites and materials sources, stumps, roots, etc., shall be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used in construction.

3.2 SOIL RETENTION BLANKET

Soil retention Blankets shall be installed in accordance with Manufacturers recommendations.

3.3 NOT USED

3.4 HYDRO MULCHING

Seed or seed mixture, in the quantity specified, shall be uniformly distributed over the areas shown on the plans where directed. Seed and fertilizer to be distributed as a water slurry, and the mixture shall be applied to that area to be seeded within 30 minutes after all components are placed in the equipment. After planting, the seed shall be raked or harrowed into the soil to a depth of approximately 1/4 inch (6mm). The planted area shall then be rolled with a smooth roller, developing 15 to 25 psi (100 to 170 kp) contact pressure upon the planted surface area and giving smooth surface without ruts or tracks. After compacting is completed, the planted area shall be watered sufficiently to assure uniform moisture from the surface to a minimum of six inches (150 mm) in depth.

END OF SECTION

SECTION 313116
TERMITE CONTROL

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS
 - A. Provisions established within General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.
- 1.2 **SECTION INCLUDES**
 - A. **Soil treatment below structural slabs and at foundation perimeter for subterranean insects**
- 1.3 QUALITY ASSURANCE
 - A. **Applicator:** Company specializing in soil treatment for termite control with **10 years documented experience** installing specified product.
 - B. **Materials:** Provide certification that toxicants conform to specified requirements.
 - C. **Material Packaging:** Manufacturer's labels and seals identifying content.
- 1.4 REGULATORY REQUIREMENTS
 - A. Conform to applicable requirements of authorities having jurisdiction for application licensing and authority to use toxicant chemicals.
- 1.5 SUBMITTALS
 - A. Submit product data and manufacturer's installation instruction under provisions of Section 013300.
 - B. Indicate toxicants to be used, composition by percentage, dilution schedule, and intended application rate.
- 1.6 **WARRANTY**
 - A. **Provide 5 year warranty for material and installation** under provisions of Section 017800.
 - B. **Warranty: Cover against invasion or propagation of subterranean termites, damage to building or building contents caused by termites, and repairs to building or building contents so caused.**
 - C. **Inspect work annually and report in writing to Owner.**
 - D. Owner reserves right to renew warranty for an additional 5 years after the initial 5 year period.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. **Acceptable Manufacturers and Products:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. **Termiticides:**
 - a. Aventis Environmental Science USA LP; Termidor
 - b. Bayer Corporation; Premise 75
 - c. Dow AgroSciences LLC; Equity
 - d. FMC Corporation, Agricultural Products Group; Dragnet SFR
 - e. Syngenta; Altriset
 - B. Substitutions: Submit in accordance with Section 016000.

2.2 SOIL TREATMENT

- A. **Termiticide:** Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

2.3 MIX DILUTION

- A. Dilute toxicant chemical as recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION/PREPARATION

- A. Verify the soil surfaces are unfrozen, sufficiently dry to absorb toxicant, ready to receive treatment.
- B. Beginning of application means acceptance of soil conditions.

3.2 APPLICATION

- A. **General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for EPA-Registered Label for products preparation before beginning application of termite control treatment.** Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Verify the soil surfaces are unfrozen, sufficiently dry to absorb toxicant, ready to receive treatment.
- C. Beginning of application means acceptance of soil conditions.
- D. **Apply toxicant no more than 12 hours prior to installation of vapor barrier under slab-on-grade.**
- E. Apply toxicant in accordance with manufacturer's instructions.
- F. **Apply extra treatment to structure penetrations, pipe, ducts, expansion joints, and other soil penetrations.**
- G. Apply as a coarse spray to ensure uniform distribution.
- H. Coordinate soil treatment at foundation perimeter with finish grading and landscaping work to avoid disturbance of treated soil. **Retreat disturbed treated soil.**
- I. Do not apply soil treatment solution until excavating, filling and grading operations are completed, except as otherwise required in construction operations. To insure penetration, do not apply soil treatment to excessively wet soils or during inclement weather.
- J. Post signs in the areas of application, warning workers that soil poisoning has been applied. Remove signs when areas are covered by other construction.

3.3 RETREATMENT

- A. If inspection identifies the presence of termites, retreat soil and retest.
- B. Use same toxicant as for original treatment.

END OF SECTION

SECTION 31 63 29

DRILLED PIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Dry-installed drilled piers.
- B. Work Included
 - 1. Furnish all labor and materials required to construct drilled concrete piers complete including layout, excavation of shafts, excavation of belled bottoms, temporary steel casings, fabrication and installation of reinforcing steel, furnishing and placing concrete, setting anchor bolts and removal of spoil.
- C. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for general structural and building applications of concrete.
 - 2. Division 5 Section "Structural Steel" for anchor rods installed in drilled piers.

1.3 UNIT PRICES

- A. Basis of Bids: Base bids on indicated number of drilled piers; design length from top elevation to bottom of shaft and diameter of shaft.
- B. Basis for Payment: Payment for drilled piers will be made on actual net volume of drilled piers in place and approved. Actual length and shaft diameter may vary to coincide with elevations where satisfactory bearing strata are encountered, and with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts.
 - 1. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for complete drilled-pier installation.
 - 2. See Division 1 Section "Unit Prices" for list of unit prices.
- C. Contract price shall be based on base lengths of piers shown on the Drawings. Unit prices shall be as follows:

1. Unit prices per linear foot for piers longer or shorter than base lengths.
2. Unit prices per linear foot for casing. Measurement for payment shall be from top of pier to top of bearing stratum.

D. The cost of casings shall be included as an alternate price.

E. Unit prices shall include all labor and materials including overhead and fees for drilled concrete piers. Adjustments to the Contract shall be based on total linear feet greater than or less than the sum of the base lengths of each pier size. Additional penetration in the bearing stratum greater than the specified penetration shall not be included in determination of increases or decreases of pier lengths related to adjustments in the Contract.

1.4 SUBMITTALS

A. Submittals for Review:

1. Shop Drawings: Indicate dimensioned plan layout, dowel and anchor bolt setting plans including templates, drilled pier shaft sizes, casing sizes, top elevation and details of reinforcing steel.

B. Submittals for Information:

1. Pier Drilling Log: Report of drilled concrete pier construction including actual elevations of top and bottom of each pier, elevation of bearing stratum, penetration into bearing stratum, deviations of pier centerline and plumbness, shaft size, presence of water, use of temporary casing, placement of concrete, and time of start and finish of excavation

C. Product Data: For each type of product indicated.

D. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Laboratory Test Reports: For evaluation of concrete materials and mix design.

E. Record drawings at Project closeout according to Division 1 Section "Closeout Procedures."

1.5 QUALITY ASSURANCE

A. Installer: Company specializing in performing the work of this Section with minimum three projects in similar soil and rock conditions, and with similar shaft sizes, depths, and quantities.

B. Drilled-Pier Standard: Comply with provisions in ACI 336.1, "Reference Specifications for the Construction of Drilled Piers," unless modified in this Section.

C. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

- D. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E 548.
- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
 - 1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
- B. Site Information: A geotechnical report has been prepared for this Project and is referenced elsewhere in the Project Manual for information only.
 - 1. Information regarding site conditions is provided for the convenience of the Contractor and is not a warranty that the information represents site conditions that may be encountered. The Owner shall not be responsible for interpretations or conclusions drawn from the information provided by the Contractor.
 - 2. Additional borings or other exploratory work may be conducted by the Contractor at no cost to the Owner.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 82, as drawn.
- C. Deformed-Steel Wire: ASTM A 496.
- D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain. Cut bars true to length with ends square and free of burrs.
- E. Bar Supports: Furnish spacers to maintain required concrete cover to sides and bottom of excavation.
 - 1. Shaftspacer Systems, Foundation Technologies, Inc., Tucker, Georgia.
 - 2. "Centraligner" and "Hijacker", Pieresearch, Arlington, Texas.

2.2 CONCRETE MATERIALS

- A. Provide concrete materials in accordance with Division 3 "Cast-in-Place Concrete."

2.3 STEEL CASINGS

- A. Steel Pipe Casings: ASTM A 283/A 283M, Grade C; or ASTM A 36/A 36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

2.4 CONCRETE MIX

- A. Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test data bases.
 - 1. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis.
- B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): As specified.
 - 2. Minimum Slump: As specified.
 - 3. Do not air entrain concrete for drilled piers.
- C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval of proposed changes to concrete-mix proportions.

2.5 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. Do not add water to concrete mix after mixing.
 - 2. Maintain concrete temperature to not exceed 95 deg F.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

- A. Unclassified Excavation: Excavation is unclassified and includes excavation to bearing elevations regardless of character of materials or obstructions encountered.

1. Obstructions: Unclassified excavation includes removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions.
 2. Obstructions: Removal of unanticipated boulders, concrete, masonry, or other unforeseen obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work, will be paid according to Contract provisions for changes in the Work.
- B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
- C. Excavate shafts for drilled piers to indicated diameters and elevations. Remove loose material from bottom of excavation.
1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
 2. Remove water from excavated shafts before concreting.
- D. Notify and allow Owner's testing and inspecting agency to test and inspect bottom of excavation prior to placing reinforcement and concrete. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
1. Do not excavate shafts deeper than elevations indicated, unless approved by Architect.
 2. Additional authorized excavation will be paid according to Contract provisions for changes in the Work.
- E. Excavate shafts for closely spaced drilled piers and those occurring in fragile or sand strata, only after adjacent drilled piers are filled with concrete and allowed to set.
- F. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.
- G. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
1. Maximum Variation From Vertical: One percent of length.
 2. Maximum Variation From Design Top Elevation: Plus 1 inch to minus 3 inches.
 3. Maximum Out-of-Position: One twenty-fourth of the shaft diameter or 3 inches, whichever is less.
 4. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.
- H. Inspection: Each drilled pier must be inspected and tested by Owner's testing and inspecting agency before placing concrete.
1. Provide and maintain facilities with equipment required for testing and inspecting excavations. Cooperate with testing and inspecting personnel to expedite the Work.
 2. Notify Architect and testing agency at least six hours before excavations are ready for tests and inspections.

3.3 STEEL REINFORCEMENT

- A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
- D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover to reinforcement.
- E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
- F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.
 - 1. Concrete shall be placed within the time limit stated on the Drawings.
 - 2. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete and insert joint dowel bars. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.
- B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
 - 1. Where concrete cannot be directed down shaft without striking reinforcing, place concrete with chutes, tremies, or pumps. Use tremies where a drop of more than 25'-0" is required.
 - 2. Vibrate top 60 inches of concrete.
- C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.
 - 1. Vibrate top 60 inches of concrete after withdrawal of temporary casing.
- D. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.
- E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.
- F. When hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no greater than 90 deg F.
1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit reports during excavation and concrete placement for drilled piers.
- B. A drilled-pier report will be prepared by Owner's testing and inspecting agency for each drilled pier as follows:
1. Actual top and bottom elevations.
 2. Top of rock elevation.
 3. Description of soil materials.
 4. Description, location, and dimensions of obstructions.
 5. Final top centerline location and deviations from requirements.
 6. Variation of shaft from plumb.
 7. Shaft excavating method.
 8. Design and tested bearing capacity of bottom.
 9. Depth of rock socket.
 10. Levelness of bottom and adequacy of cleanout.
 11. Ground-water conditions and water-infiltration rate, depth, and pumping.
 12. Description, diameter, and top and bottom elevations of temporary or permanent casings.
 13. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
 14. Date and time of starting and completing excavation.
 15. Inspection report.
 16. Position of reinforcing steel.
 17. Concrete placing method, including elevation of consolidation and delays.
 18. Elevation of concrete during removal of casings.
 19. Locations of construction joints.
 20. Remarks, unusual conditions encountered, and deviations from requirements.
 21. Concrete testing results.
- C. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by Owner's testing and inspecting agency. Final evaluations and approval of data will be determined by Architect.
- D. Concrete: Sampling and testing of concrete for quality control per Section 03 30 00.

3.6 DISPOSAL OF MATERIALS

- A. Remove surplus excavated material and slurry and legally dispose of it off Owner's property.

END OF SECTION 31 63 29

SECTION 321313

PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not at all inclusive but listed as a guide, shall include:
 - 1. Furnish all labor, tools, equipment and incidentals to complete the work.
 - 2. Concrete paving, integral curbs, and miscellaneous other uses.
 - 3. Sawed joints.
 - 4. Sealing of Joints.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Site Preparation - Section 311000
 - 2. Pavement Markings - Section 321723
 - 3. Sidewalks and Driveways Approaches - Section 322000
 - 4. Concrete Curbs and Gutters - Section 321600

1.3 QUALITY ASSURANCE

- A. Source Quality Control: Testing and Inspection of Concrete as specified in Section 01410.
- B. Allowable Tolerances: Surfaces true to plane, in longitudinal direction to required grade, within 5/8" in 10 feet, plus or minus, non-cumulative.
- C. Concrete Mix Design Criteria:
 - 1. Contractor shall provide and pay for design of concrete mixes. Design of concrete mixes shall be performed by a testing laboratory selected by Contractor and approved by Architect. Design methods shall be in accordance with ACI 211.
 - 2. For each concrete mix design, make three trial mixes using proposed aggregate, in accordance with ACI 211. Experience Method is acceptable.
 - 3. Check mix designs and revise if necessary wherever changes are made in aggregates or in surface water content of aggregate or workability of concrete.
 - 4. Source Quality Control: Periodically inspect and control concrete mixing and loading of transit mix trucks at batch plant at intervals as agreed to and by Laboratory personnel.
 - 5. Concrete mix designs which are currently being used on TxDOT projects, certified by the concrete supplier are generally acceptable.

1.4 REFERENCE STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 211.1-77 - Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete.
 - 2. ACI 305-77 - Recommended Practice for Hot Weather Concreting.
 - 3. ACI 306-72 - Recommended Practice for Cold Weather Concreting
 - 4. ACI 315-74, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
- B. American Society for Testing and Materials (ASTM) (latest edition)

1. ASTM A184 - Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
2. ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement
3. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM C33 - Concrete Aggregates
5. ASTM C94 - Ready-Mix Concrete
6. ASTM C150 - Portland Cement
7. ASTM C171 - Sheet Materials for Curing Concrete
8. ASTM C260 - Air-Entraining Admixtures for Concrete
9. ASTM C309 - Liquid Membrane - Forming Compound for Curing Concrete
10. ASTM C494 - Chemical Admixtures for Concrete
11. ASTM C618 - Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.
12. ASTM C1549 - C1549-02 Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
13. ASTM D1190 - Concrete Joint Sealer, Hot-Poured Elastic Type,
14. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (non-extruding and resilient bituminous types).
15. ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

- C. Texas Department of Transportation (TxDOT) 2014 Standard Specification for Construction of Highways, Streets and Bridges.

1.5 SUBMITTALS

- A. General: Submit in accordance with Section 013300
- B. Mix Designs: Submit copies of each laboratory trial mix design. Record of previous satisfactory performance for the proposed mix design may be submitted in lieu of above.
- C. Product Data: Submit Manufacturer's descriptive literature and installation instructions for specified products.
- D. Certificates: Submit Manufacturer's certification that materials meet specification requirements.

1.6 JOB CONDITIONS

- A. Environmental Conditions: Except by written authorization of Owner, no concrete shall be placed when the air temperature is less than 40°F (4°C) and falling, but may be placed when the temperature is above 35°F (2°C) and rising, temperature taken in shade away from artificial heat. No concrete shall be placed in rain, sleet, snow or on a frozen subgrade.
- B. Allowable Concrete Temperatures:
 1. Cold Weather: Maximum and Minimum, ASTM C94, conform to ACI 306.
 2. Hot Weather: Conform to ACI 305.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type 1.
- B. Fly Ash: The use of fly ash will be permitted when the amount and type has been established by laboratory data. The maximum amount allowed shall not exceed 20 percent of absolute volume of the specified cement content.

C. Aggregates: ASTM C33

1. Coarse aggregate: Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone or combinations thereof and shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material either free or as an adherent coating. When white Portland cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. Coarse aggregate shall not contain more than 0.25 percent by weight of clay lumps, nor more than five (5.0) percent by weight of laminated and/or friable particles when tested in accordance with Test Method Tex-413-A. Coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with Test Method Tx-410 A.

Unless otherwise shown on the plans, coarse aggregate from each source will be subjected to five (5) cycles of both the sodium sulfate and the magnesium sulfate soundness test in accordance with Test Method Tex-411-A. When the loss is greater than 12 percent with sodium sulfate and/or 18 percent with magnesium sulfate, further testing will be required prior to acceptance or rejection of the material. A satisfactory record under similar conditions of service and exposure will be considered in the evaluation of material failing to meet these requirements.

When tested in accordance with Test Method Tex-401-A, the coarse aggregate, including combinations of aggregates when used, shall conform to the gradation requirements shown in Table 1.

TABLE 1
COARSE AGGREGATE GRADATION CHART

Aggregate Grade No.	Nominal Size In.	Percent Retained on Each Sieve								
		2-1/2 in.	2 in.	1-1/2 in.	1 in.	3/4 in.	2 in.	3/8 in.	No. 4	No. 8
1	2	0	0-20	15-50		60-80			95-100	
2 (467)*	1-1/2		0	0-5		30-65		70-90	95-100	
3	1-1/2		0	0-5		10-40	40-75		95-100	
4 (57)*	1			0	0-5		40-75		90-100	95-100
5 (67)*	3/4				0	0-10		45-80	90-100	95=100
6 (7) *	2					0	0-10	30-60	85-100	95-100
7	3/8						0	5-30	75-100	
8	3/8						0	0-5	35-80	90-100

Numbers in parenthesis indicate that these gradations conform to corresponding ASTM gradation in ASTM C33

The loss of decantation in accordance with Test Method Tex-406-A plus the allowable

weight of clay lumps shall not exceed one (1) percent, or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from the crushing of stone, if the material is finer than the 200 sieve is definitely established to be the dust of fracture, essentially free from clay or shale, as established by Part III of Test Method Tex-406-A, the percent may be increased to 1.5.

2. Fine aggregate: Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. When white Portland cement is specified the fine aggregate used in the concrete shall be light colored. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent of weight of clay lumps. When the aggregate is subjected to the color test for organic impurities in accordance with Test Method Tex-408-A, the test result shall not show a color darker than standard.

Unless otherwise shown on the plans, the acid insoluble residue of fine aggregate used in concrete subject to direct traffic shall not be less than 60 percent by weight when tested in accordance with Test Method Tex-612-J.

When tested in accordance with Test Method Tex-401-A, the fine aggregate or combinations of aggregates, including mineral filler, shall conform to the gradation requirements shown on Table 2.

TABLE 2

FINE AGGREGATE GRADATION CHART

Aggregate Grade No.	Percent Retained on Each Sieve							
	3/8 in.	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
1	0	0 to 5	0 to 20	15 to 50	35 to 75	65 to 90	90 to 100	97 to 100

Where manufactured sand is used in lieu of natural sand, the percent retained on the No. 200 sieve shall be 94 to 100.

Where the sand equivalent value is greater than 85, the retainage on the No. 50 sieve may be 65 to 94 percent.

Fine aggregates will be subjected to the Sand Equivalent Test (Test Method Tex-203-F). The sand equivalent shall not be less than 80 unless otherwise shown on the plans.

For all classes of concrete the fineness modulus shall be between 2.30 and 3.10 as determined by Test Method Tex-402-A.

C. NOT USED

- D. Mortar and Grout: Mortar and grout shall consist of one (1) part Portland cement, two (2) parts finely graded sand and sufficient water to provide the desired consistency. Mortar may contain admixtures.

Mortar shall have a consistency such that the mortar can be easily handled and spread by trowel. Grout shall have a consistency such that the grout will flow into and completely fill all voids.

When required to prevent color difference, white cement shall be added to produce the color required. When shown on the plans or in the specifications, or when required by the architect, latex adhesive conforming to the requirements of Departmental Material Specification D-9-8110 shall be added to the mortar.

E. Storage of Materials:

1. Cement, Fly Ash and Mineral Filler: All cement, fly ash and mineral filler shall be stored in well ventilated weatherproof buildings or approved bins, which will protect them from dampness or absorption of moisture. Each shipment of packaged cement shall be kept separated to provide easy access for identification and inspection.
2. Aggregates: The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. The bottom six (6) inch layer of aggregate shall not be disturbed or used without recleaning.

When conditions require the use of two (2) or more sizes of aggregates, the aggregates shall be separated to prevent intermixing. Where space is limited, stockpiles shall be separated by physical barriers. Aggregates from different sources shall be stored in different stockpiles unless the aggregates are pre-blended.

Methods of handling aggregates during stockpiling and their subsequent use shall be such that segregation will be minimized.

All aggregate shall be stockpiled at least 24 hours to reduce the free moisture content. In order to control absorption, stockpiles shall be sprinkled.

To assure uniform concrete, aggregate stockpiles shall be maintained at reasonable uniform moisture content.

3. Admixtures. Admixtures shall be stored in accordance with TxDOT Item 437, Concrete Admixtures.

F. Measurement of Materials:

Except as noted below, the measurements of materials used in batches of concrete shall be by weight.

Water may be measured by volume or weight.

Cement and fly ash shall be weighed separately from other materials. Weighing of sacked cement will not be required. When sacked cement is used, the quantity of cement per batch shall be based upon using full bags of cement. Batches involving use of fractional bags will not be permitted.

G. Admixtures:

1. Air entraining agents: ASTM C260.
2. Cement dispersing agents: ASTM C494.

H. Water: Clean and potable.

I. Reinforcing Steel:

1. Bar mats: ASTM A184, Grade 60.
 2. Deformed billet steel: ASTM A615, Grade 60.
- J. Welded wire fabric: ASTM A185.
- K. Dowels and Sleeves: Plain round bar dowels, sized as detailed, conforming to reinforcing steel requirements, coated with bituminous paint on one-half or length. Provide sleeves as detailed, closed at one end, and allowing one inch movement at closed end.
- L. Supports: Provide chair spacers and other required supports in accordance with requirements of ACI 315.
- M. Joint Assemblies: Metal positioning and supporting devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes, etc.) Shall be as shown on the plans or may be approved similar devices of equivalent greater strength. The support devices shall secure the joint assembly and dowels within the allowable tolerances while providing no restraint against joint movement. Dowels used in joint assemblies shall be secured in parallel position by a transverse metal brace or may be secured by approved other devices. The devices shall provide positive mechanical connection between the brace and each unit (other than by wire tie) and prevent transverse movement of each load transmission device.
- N. Joint fillers, conforming with ASTM D1751.
- O. Wood Form: Good grade lumber, sound and free of warp, minimum 2 inch nominal thickness, except where extremely short radio of curves require thinner forms.
- P. Curing compound: Liquid membrane, ASTM C309, Type 2 white pigmented.
- Q. Curing sheets: ASTM C171.
- R. Joint Sealing Compound: Hot rubber compound or silicone sealing compound, as per General Notes.
- 2.2 CONCRETE MIX
- A. Concrete Quality: In accordance with approved mix design and following requirements:
1. Slump: 5" maximum for flatwork, 6" maximum for catch basins, etc.
 2. Compressive strength: Not less than 3,000 psi at 28 days or as shown on the plans.
 3. Entrained air: Concrete mix shall contain 5% entrained air plus or minus 1%.
 4. Admixture: Introduce in quantities and according to methods recommended by admixture manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that earthwork is completed to correct line and grade.
- B. Check that subgrade is smooth, compacted and free of frost or excessive moisture.
- C. Do not commence work until conditions are satisfactory.

3.2 MAINTAINING SUBGRADE PRIOR TO PLACING CONCRETE

- A. Provide complete drainage of subgrade during entire construction period. On elevated grades,

direct surface water to gutters, paved ditches or drains by proper grading of subgrade.

- B. Maintain subgrade in a smooth, compacted condition at required section and grade until concrete pavement is ready to be placed. Keep subgrade thoroughly wetted down sufficiently in advance of placing concrete to insure a firm moist subgrade condition for at least 2 inches below prepared surface.
- C. Prepare only a sufficient amount of subgrade in advance of placing of concrete to enable work to proceed smoothly and effectively. Avoid placing of equipment or hauling equipment over completed subgrade until placement of concrete has been completed.
- D. The use of sand cushion for subgrade leveling purposes is prohibited.

3.3 INSTALLATION

- A. Forms:
 - 1. Set forms accurately to required grades and alignment
 - 2. Adequately brace to withstand loads applied during concrete placement.
 - 3. Install flexible or curved forms of wood or metal for curves with radius of 300 feet or less.
 - 4. Leave forms in place for a minimum of 12 hours after completion of the finishing operation.
- B. Joint Fillers:
 - 1. At driveway to street connections, accurately shape joint filler to concrete section per Paving Details.
 - 2. Securely fasten filler in place and in contact with subgrade for its entire length. Provide holes for dowel bars not more than 1/8" larger than bar diameter.
 - 3. Where joint sealant or sealing compound is scheduled, provide removable tacked-on strips to provide a recess for sealant or compound.
- C. Reinforcement:
 - 1. Install reinforcing steel in middle of the pavement thickness.
 - 2. Steel shall be free of rust or mill scale, dirt or oil.
 - 3. Reinforcing shall be supported by chairs. Pulling-up reinforcing that is laying on the subgrade while the pour is under way will not be permitted.
- D. Placing and Finishing:
 - 1. Placing: Deposit concrete so that specified slab thickness will be obtained after vibrating and finishing operations. Minimize handling to prevent segregation. Consolidate concrete by suitable means to prevent formation of voids or honeycombs. Exercise care to prevent disturbance of forms.
 - 2. Finishing: After consolidation and screeding, float concrete level to within specified tolerances. Use a straight edge to level and test surface in longitudinal direction to required grade. Finish surface to a gritty texture similar to a heavy broomed finish. Finish edges to provide a smooth dense surface with 1/8" radius.

3.4 JOINTS

- A. Intentional stoppage of concrete placing shall be at planned location of either an expansion joint or construction joint.
- B. When stoppage occurs at an expansion joint, install joint assembly as shown on drawings for an expansion joint, with a bulkhead of sufficient section drilled to accommodate required dowels.

- C. When stoppage occurs at a construction joint, install joint assembly as detailed on drawings for a construction joint.
 - 1. Provide a bulkhead of sufficient section to prevent deflection, or loss of shape of concrete section. Drill bulkhead to permit continuation of longitudinal reinforcing steel through construction joint.
 - 2. Immediately upon unintended stoppage of concrete placing, place available concrete to a line and install bulkhead perpendicular to surface of pavement and at a required elevation. Place and finish concrete to this bulkhead. Remove and dispose of concrete remaining on subgrade ahead of bulkhead.
 - 3. When placing of concrete is resumed before concrete has set to extent that concrete will stand on removal of bulkhead, new concrete shall be rodded with the first; otherwise, carefully preserve joint face.
 - 4. An edge created by a construction joint of this type shall have a joint steel seal space as detailed on drawings.
 - 5. Install standard concrete street header as per City standards when joining old pavement to new pavement, unless otherwise shown on the drawings.
- D. Provide sawed dummy joints spaced apart as indicated on the drawings (approximately 15 ft on center maximum).
 - 1. Saw joints after completion of finishing operations as soon as concrete has hardened to extent necessary to prevent raveling of joint or damage to adjacent concrete surfaces.
 - 2. Saw joints same day that concrete is placed except that sawing of joints in concrete placed late in day may be delayed until morning of following day.
 - 3. In any event, saw joints within 18 hours after placing concrete.
 - 4. Use a power-driven concrete saw made especially for sawing concrete and maintain in good operating condition.
 - 5. Saw blades shall make a clean, smooth cut, producing a groove 1/8" to 3/16" wide and depth equal to 1/4 of slab thickness, minimum one inch depth.
 - 6. Do not cut existing reinforcement.
 - 7. Joints should be continuous across the slab unless interrupted by full-depth, pre-molded joint filler, and should extend completely through curb.
 - 8. Joint openings wider than one-fourth inch shall be cleaned and sealed before opening area to traffic.
- E. Expansion joints or isolation joints shall be used to isolate fixed objects abutting or within the paved area. They shall contain pre-molded joint filler for the full depth of the slab and shall be sealed prior to opening to traffic.

3.5 CURING

- A. Apply membrane curing compound at a uniform rate of approximately 200 square foot per gallon, or as recommended by manufacturer, as soon as finishing operation has been completed and concrete has lost its water sheen.
- B. At contractor's option, curing sheets may be used, held in place with moist sand.
- C. Curing procedure shall protect concrete, including concrete edges and curbs, against loss of moisture and rapid temperature change for a period of not less than 4 days from beginning of curing operation, without damage or marking of finished concrete surface.
- D. Do not allow traffic on concrete for a minimum period of 7 days after placing.

3.6 COLD WEATHER PROTECTION

- A. When concrete is placed in cold weather and the temperature may be expected to drop below

35°F, provide cold weather protection in accordance with ACI 306.

- B. When ambient temperature is expected to fall below 32°F during day or night, cover concrete with protective material to a sufficient depth to prevent freezing of concrete.
- C. Protect concrete from freezing temperatures for a minimum of 5 days after placing.
- D. Remove and replace concrete damaged by frost action.

3.7 SEALING JOINTS

- A. Cleaning joints: Prior to applying joint sealing compound, clean joints with compressed air to obtain a clean and dry surface on face of joints so that sealing material will adhere.
- B. When hot rubber compound is called for in the General Notes:
 - 1. Melt joint sealing compound to proper consistency for pouring using continuous agitator type kettle with calibrated thermometer. Do not heat above 450°F.
 - 2. Continuously apply joint sealing compound full depth of joint recesses and flush with concrete surface, in accordance with manufacturer's directions. Do not apply when ambient temperature is below 35°F.
- C. When silicone sealing compound is called for in the General Notes:
 - 1. Apply sealing compound as per manufacturer's instructions.

3.8 PAVEMENT STRENGTH TEST

- A. During the progress of the work, the Contractor shall cast test cylinders to maintain a check on the compressive strengths of the concrete being placed.
- B. Four test cylinders shall be taken from a representative portion of the concrete being placed for every 100 cubic yards of concrete pavement placed, but in no case shall less than two sets of cylinders be taken from any day's placement.

After the cylinders have been cast, they shall remain on the job site undisturbed for 24 hours and then transported, moist cured, and tested by the Testing Laboratory designated by the Owner.

Two of the cylinders in each set shall be tested in seven days; and then, if in the opinion of the engineer the seven day test results are low enough, the other two cylinders in each set may be tested in 28 days.

If the 28 day test results indicate deficient strength, the Contractor may, at his option and expense, core the pavement in question and have the cores tested by an approved laboratory to override the results of the cylinder tests.

END OF SECTION

SECTION 321600

CONCRETE CURBS AND GUTTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not at all inclusive but listed as a guide, shall include:
 - 1. Furnish all labor, tools, equipment and incidentals to complete the work.
 - 2. Concrete paving, driveway approaches, integral curbs, curbs and gutters, concrete for sidewalks, riprap, manholes, headwalls, steps planters and miscellaneous other uses.
 - 3. Expansion joint fillers.
 - 4. Sawed joints.
 - 5. Sealing of Joints.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections. Other Sections containing relate work include but are not limited to the following:
 - 1. Earthwork - Section 312315
 - 2. Pavement Markings - Section 321723
 - 3. Sidewalks and Driveways Approaches - Section 322000
 - 4. Portland Cement Concrete Paving - Section 321313

1.3 REFERENCES

- A. American Society for Testing and Materials, ASTM.
- B. Texas Department of Transportation Standards Specifications for Construction of Highways, Streets and Bridges, 2014, TxDOT.

1.4 PRODUCT HANDLING

- A. Protection:
 - 1. Protect from damage until acceptance.
 - 2. Exclude traffic for 14 days after placement.

1.5 CONTROL

- A. Grade Control: Establish and maintain required lines and grades.
- B. Traffic Control:
 - 1. Maintain vehicular and pedestrian traffic as required for other construction activities.
 - 2. Provide barricades, warning signs, and warning lights as required to control traffic, maintain safety and cause least interruption of work.

PART 2 - PRODUCTS

- 2.1 REINFORCEMENT: As noted on Drawings.
- 2.2 CONCRETE: 3,000 psi at 28 days or as shown in plans.
- 2.3 FORMS:

- A. Steel or wood.
- B. Straight and free of distortion and defects.
- C. Radius Bends: Flexible spring steel or laminated boards.
- D. Form Oil: Non-staining, clear, paraffin base.

2.4 FILLERS AND JOINTS:

Expansion Joints: Premolded joint filler.

- 2.5 FLY ASH: The use of fly ash will be permitted when the amount and type has been established by laboratory data. The maximum amount allowed shall not exceed 20 percent of absolute volume of the specified cement content.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof roll prepared subgrade to check for unstable areas requiring additional compaction.
- B. Do not begin work until any discrepancies have been corrected.
- C. Remove loose material from subgrade immediately prior to placing concrete.

3.2 INSTALLATION

- A. Forms:
 - 1. Set to required grades and lines.
 - 2. Brace securely with wood or metal stakes.
 - 3. Leave in place 24 hours after concrete placement.
- B. Automatic Curb and Gutter Machine:
 - 1. May be used at the contractor's option with Owners Representative approval.
 - 2. Machine placement must produce curbs and gutters equal in all respects to formed concrete.
 - 3. If results are not acceptable, remove and replace with formed concrete.
- C. Joints:
 - 1. General:
 - a. Expansion, weakened-plane (contraction) and construction joints; true to line, face perpendicular to surface of curb and gutter.
 - b. Transverse joints: at right angles to curb center line.
 - c. Where joining existing pavement: align transverse joints with existing joints unless otherwise shown.
 - 2. Expansion Joints:
 - a. Locate at 30'-0" o.c. unless otherwise shown.
 - b. Provide where curb abuts manholes, inlets, structures, walks or other fixed objects.
 - c. Extend joint fillers full width and depth of joints.
 - d. Not less than 2 inch or more than 1 inch below finished surface.
 - e. Conform top edge to top profile of curb and gutter.

3. Weakened-plane (Contraction Joints):
 - a. Locate at 10'-0" o.c. unless otherwise shown.
 - b. Embed strips of metal or sealed wood to form joints.
 - c. Set strips in plastic concrete and remove after concrete has hardened.
4. Construction Joints:
 - a. Place at end of all pours.
 - b. Located where placement stops for more than 2 hour except where pours terminate at expansion joints.

3.3 FINISHING

- A. Broom Finish:
 1. Draw fine-hair broom across concrete surface perpendicular to line of traffic.
 2. Repeat if required to provide texture suitable to match exiting curbs.

3.4 CLEANING

- A. When construction traffic is permitted, remove surface stains and spillage of materials as they occur.
- B. Sweep and wash free of stains, discoloration, dirt and other foreign material just prior to final inspection.

END OF SECTION

SECTION 321723
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Work included in this Section, while not all inclusive but listed as a guide, shall include:
 - 1. Furnish all labor, materials, services, equipment and appliances required in conjunction with painted pavement markings.
 - 2. Layout all markings.
 - 3. Four inch (4") white color stripping for parking spaces in parking lots as indicated on site plan.

1.2 RELATED SECTIONS

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Portland Cement Concrete Paving - Section 321313

1.3 REFERENCES

- A. American Society for Testing and Materials, ASTM.
- B. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges, 2014, TxDOT.

1.4 QUALITY ASSURANCE

- A. Subcontractor for work of this section shall be of firm specializing in application of pavement markings.

1.5 PROJECT CONDITIONS

- A. Concrete paving and curbs shall have been in place a minimum of 14 days prior to application of pavement markings.
- B. Do not apply marking paint when weather is foggy or rainy, or ambient or pavement temperature are below 40 F, nor when such conditions are anticipated during eight hours after application.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Paint for markings: Equal to Standard Paints, Inc., 1007 W. Commerce Street, Dallas, Texas or Sherwin Williams Traffic Marking Paint, conforming to Fed. Spec. TT-P-115E, Type III, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surface on which pavement markings are to be applied and report any unsatisfactory conditions which will prevent the proper application of markings to the Contractor.

3.2 PREPARATION:

- A. Thoroughly clean surfaces to receive pavement markings. Layout markings in conformance with drawings. Surfaces to receive markings shall be dry.

3.3 APPLICATION

- A. Equipment: Hand operated push-type machines of a type commonly used for application of paint to pavement surfaces. Use hand-operated spray guns in areas where the push-type machines cannot be used.
- B. Application: Apply paint in one coat evenly to clean, dry surfaces. Apply marking paint at not less than rate of one gallon per 100 sq.ft. (equivalent to approximately one gallon for 300 lineal feet of 4" wide strip), to result in uniform complete coverage of surfaces to be painted. Apply paint only when air and surfaces temperatures are above 40 F. Provide guide lines and template necessary to control paint application. Edges of markings shall be sharply outlined.
- C. Protection: Protect newly painted surfaces from damage by vehicles during time required for paint to harden sufficiently to withstand traffic. During period of high wind, discontinue painting operations.

3.4 CLEANING

- A. Cleanup all debris caused by the work of this section, keeping the premises clean and neat at all times.

END OF SECTION

SECTION 331100

WATER CONDUIT INSTALLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Work included in this Section, while not all inclusive but listed as a guide, shall include:
 - 1. Furnishing of all labor, tools, materials, equipment and incidentals required to complete the work.
 - 2. Layout of the work.
 - 3. Installation of water mains, fire hydrants, appurtenances, corrosion protection; and connection to existing system.
 - 4. Sterilization
 - 5. Testing
 - 6. Clean up

1.2 RELATED SECTIONS:

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the Work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Excavation and Backfill for Conduits - Section 31 23 34

1.3 REFERENCES:

Meet requirements and recommendations of applicable portions of the Standard listed.

- A. American Society for Testing and Materials.
 - 1. ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) compounds and Chlorinated Poly (Vinyl Chloride) (PVC) Compounds.
 - 2. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - 3. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR series).
 - 4. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- B. American Water Works Association (AWWA):
 - 1. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
 - 2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3 Inches through 48 inches, for Water and Other Liquids.
 - 3. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - 4. AWWA C153 - Ductile Iron Compact Fittings, 3 inches through 16 inches, for Water and Other Liquids.
 - 5. AWWA C502 - Dry-Barrel Fire Hydrants.
 - 6. AWWA C509 - Resilient Seated Gate Valves, for Water and Sewerage Systems.
 - 7. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
 - 8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. Through 12 in., for Water.
- C. Texas Natural Resource Conservation Commission Rules & Regulations for Public Water Systems, March 1993.

1. Chapter 290.41 Water Sources.
2. Chapter 290.44 Water Distribution

- D. Texas Department of Public Transportation Standard Specifications for Construction of Highways, Streets, and Bridges, 2014, TxDOT.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PRESSURE PIPE AND FITTINGS:

- A. General. Ductile-iron pressure pipe 3" in diameter and larger shall conform to the current American National Standard for Ductile-Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids, AWWA Standard C151 (ANSI A21.51).
- B. Design Requirements. The ductile-iron shall conform in all respects to the specifications for Ductile Iron Castings, ASTM Designation A 536, except the grade shall be as follows unless specified otherwise in the special provisions or in the plans:
- C. Pipe class shall be as shown on the plans.
6" through 12" shall be thickness Class 50. For larger diameters or deeper cover, special design shall be provided.
- D. Joints. All ductile-iron pressure pipe shall be furnished with one of the following types of joints and as described in the proposal or bid request:

<u>Type Joint</u>	<u>AWWA Standard</u>
Push-on	AWWA C111
Mechanical Joint	AWWA C111
Flanged Ends	AWWA C110

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a high-strength low-alloy corrosion-resistant steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM Designation A 325 (Type 3). All screwed flanges shall be ductile iron.

- E. Coating and Lining. All ductile-iron pipe shall be cement-mortar lined inside in accordance with AWWA Standard C104 (ANSI A21.4).
- F. Fittings. Fittings shall be of ductile iron and shall conform to the current American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In., for water and Other Liquids, AWWA Standard C110 (ANSI A21.10) or American National Standard for Ductile Iron Compact Fittings, 3 In. through 12 In. for Water and Other Liquids, AWWA Standard C153 (ANSI A21.53), unless otherwise specified in the proposal, special specification or in the plans. All Fittings shall be rated for a minimum of 250 psi working pressure.
- G. Wrapping. Buried pipe and fittings shall be wrapped with 8 mil. polyethylene encasement, AWWA C105.
- H. Underwriter's Approval. Ductile-iron pipe shall be approved by the Underwriters' Laboratories, Inc., and shall be accepted by the State Fire Insurance Commission for use in water distribution systems without penalty. All pipe and fittings shall be new.
- I. Tests. All ductile-iron pipe and fittings shall be tested in accordance with the applicable

provisions of the specifications relating thereto and the class, weight, and casting period shall be shown on each pipe.

- J. Rejection. Ductile-iron and fittings may be rejected for failure to meet all of the requirements of this specification.

2.2 POLYVINYL CHLORIDE (PVC) WATER PIPES:

- A. General.
Un-plasticized polyvinyl chloride (PVC) water pipe shall meet the requirements of AWWA Standard for Polyvinyl Chloride Pressure Pipe, 4 in. through 12 in., for Water AWWA Standard C900, with cast-iron outside dimensions. Laying lengths shall be 20' ± 1".
- B. Thickness Class.
PVC water pipe shall meet the dimension ratios (DR's) and physical dimensions as shown in the following table. The pressure classification refers to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations.

PVC WATER PIPE DIMENSIONS

Nominal Size	O.D.*	Class 200 (SDR14) Min. Wall Thickness	Class150 (SDR18) Min. Wall Thickness
<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Inches</u>
4	4.800	0.343	.267
6	6.900	0.493	0.383
8	9.050	0.646	0.503
10	11.100	0.793	0.617
12	13.200	0.943	0.733

*Cast iron pipe O.D. dimensions

- C. For sizes 3/4 in. thru 2½ in., pipe shall conform to ASTM D 2411, class 200, solvent weld. Solvent welded sockets shall be schedule 40.
- D. Joints.
PVC water pipe shall be furnished with gasketed joints. Lubricant used for pipe and fittings assembly shall be nontoxic and shall have no detrimental effect to either gasket or pipe.
- E. Fittings.
Fittings for PVC water pipe shall conform to American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 in. through 48 in., For Water and Other Liquids, AWWA Standard C110 (ANSI A21.10), unless otherwise specified in the proposal, special specifications or on the other plans.

Fittings joints shall be mechanical joints. Bolts and nuts for mechanical joints shall be of high-strength, corrosion-resistant, low-alloy steel and shall conform to ASTM Designation A 325 (Type 3).
- F. Approvals.
PVC water pipe shall be approved by the Underwriters' Laboratories and shall be accepted by the State Fire Insurance Commission for use in water distribution systems in cities and towns of Texas. PVC water pipe shall also bear the seal of approval (or "NSF" mark) of the National

Sanitation Foundation testing Laboratory for potable water pipe.

- G. Rejection.
PVC water pipe may be rejected for failure to meet all of the requirements of this specification.
- H. Copper Tubing.
Copper tubing shall conform to ASTM B88 Type L, drawn and tempered.
- I. Solvent Cement.
Solvent Cement shall conform to ASTM D2564 for PVC pipe and fittings.
- J. Valves. (For sizes 3/4 in. thru 2½ in.)
 - 1. Acceptable Manufacturers.
 - a. Rain Bird Sprinkler Mfg. Corp
 - b. The Toro Company
 - c. Spears (Ball Valves)
 - d. Wilkins (Backflow Preventers)

2.3 GATE VALVES:

- A. General. All gate valves 3" through (121.9cm) shall conform to the AWWA Standard for Gate Valves--3 In. through 48 In. NPS--for Water and Sewage Systems, AWWA Standard C509. All gate valves shall be iron body, bronze mounted, double disc, parallel seat, non-rising stem, internal wedging type. Valves must embody the best workmanship and finish. Valve design shall effect minimum torque designs effectively reducing friction and drag through thrust collar design and trackage for gates.

2.4 VALVE BOXES:

Shall be constructed of cast iron and shall be a two piece adjustable sliding type. The cover shall have "W" or "water" cast in the top. Valve boxes shall be the standard catalog products of a reputable manufacturer.

2.5 FIRE HYDRANTS:

- A. General: Fire shall conform to the City of Wichita Falls standard details and specifications.

2.6 DETECTOR TAPE FOR UNDERGROUND FIRE PROTECTION PIPING

- A. Detector tape for identification of on-site fire protection main locations shall be manufactured by Allen Systems, Inc., Wheaton, IL 60187, or approved equal. Detector tape shall consist of a solid aluminum foil core running in the full length and width of the tape and encased in a protective, high visibility, color-coded inert plastic jacket. The detector tape shall conform to the following:
 - 1. Plastic jacket shall be impervious to alkalis, acids, and other chemicals in the soil.
 - 2. Foil core shall have a minimum thickness of 0.35mils.
 - 3. Overall thickness of the tape shall be 5.5mils, minimum.
 - 4. Tensile strength shall be 5,000psi, minimum.
 - 5. Tape width shall be three(3) inch, minimum.
 - 6. Color of tape shall be "Safety Precaution Blue"
 - 7. Tape above fire protection system piping shall be read "Caution Buried Fire Protection System Water Line Below"

- B. Installation of tape shall be twenty-four(24) inches above the pipe.

2.7 CONCRETE FOR THRUST BLOCKING:

- A. Concrete shall be in accordance with Section 03 30 00 "Cast-in-Place Concrete", compressive strength 2500 psi at 28 days.

PART 3 - EXECUTION

3.1 EARTHWORK: Refer to Section 31 20 00

3.2 BEDDING: Pipe shall be bedded as shown on the plans.

3.3 EXCAVATION AND BACKFILL FOR CONDUITS: Refer to Section 31 23 34

A. General.

1. Pipe Handling: All pipe, fittings and specials shall be handled in such a manner as not to damage the material. All dirt and trash shall be removed from the pipe prior to installation. No hooks shall be permitted. When it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be within the limits provided by the manufacturer. The pipe is to be kept clean during the laying operation and free of all dirt and trash. At the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all objects and especially water.
2. Stringing of Pipe: Stringing of pipe in advance of the laying operation shall be restricted to one week's laying and shall be done in such a manner as to create no hazard to nor interference with traffic. Ready access shall be provided to all streets, alleys and driveways. The pipe shall be protected with barricades and warning signs at all times. Any damage to the pipe shall be corrected at the expense of the Contractor.
3. Laying Underground Conduit Pipe: Previous to being lowered into the trench, each pipe shall be carefully inspected; and those not meeting specifications shall be rejected and either destroyed or removed from the job. All lumps or excrescences on the ends of conduit shall be removed before it is lowered into the trench. The pipe and specials shall be so laid in the trench that after the project is completed the interior surface shall conform accurately to the grade and alignment indicated on the plans. Bell holes shall be excavated and all pipe shall be carefully adjusted to fit snugly in cradling or bedding so that the entire length bears on cradling or bedding material with no wedging or blocking to hold up the bell. All pipe shall be laid in the dry, regardless of the type of joint used. Pipes shall be laid with the bell or groove end up grade unless otherwise approved by the engineer and shall be laid with the bell or collar away from the last section placed. Before laying the pipe, the interior of the joints shall be carefully bored smooth and clean and the annular space shall be kept free from dirt, stones or water. Pipe shall be installed and joints made up in complete conformance with the instructions and recommendations regarding proper installation and assembly furnished by the manufacturer. Proper facilities shall be provided for hoisting and lowering the section of the pipe into the trench without disturbing the prepared foundation and the sides of the trench. All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, standard pipe (short sections of pipe or bevels) shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve. When work is suspended on the line for any reason, the end of the line shall be properly closed with an effective watertight seal or plug manufactured for this purpose.
4. Existing Utilities. Pipe capable of supporting its weight approximately at right angles to the ditch shall not require additional support, unless shown on the plans, other than the

exercise of care in placing new conduit under same and in placing backfill, except when the span is excessive. Existing utilities shall be replaced with cast iron or any suitable piping to convey the contents, supported with concrete or a concrete utility support per details on the plans. After the new utility is laid, the backfill to the base of the concrete support shall be stabilized by the use of cement-stabilized soil. Pipes parallel to and in the edge of cut, shall be supported or rerouted if so indicated on the plans. Utilities parallel to and in edge of cut shall be adequately protected without additional compensation except as set out in the contract and proposal.

3.4 WATER MAIN INSTALLATION:

- A. Description. This work shall include the installation and construction, complete in place, of pipe conduits and fittings as specified herein and in conformity with the lines, grades, dimensions, materials and designs shown on the plans.
- B. Materials: The pipe shall be of the kind and strength shown on the plans and provided in the proposal and contract. Materials for corrosion protection of water conduits and appurtenances shall be of the type as may be called for on the plans or in the special specifications. Any pipe, fitting, solder or flux which is used in the installation or repair of any public water system must be lead-free. For purposes of this section, "lead-free" means solders and flux containing not more than 0.2 percent lead, and pipes and pipe fittings containing not more than 8.0 percent lead.
- C. Laying Water Conduit: All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, and the curves are flat, standard pipe shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve. Deflection of the joint to form curves shall not exceed the limits of Table 2, AWWA C-600. Where curves are sharp, short sections of pipe, bevels or bends shall be used and blocked. When pipe is cut by the Contractor to insert a valve or fitting, the bell and remaining section may be laid beyond the valve or fitting.
- D. Pipe Joints: All joints in pipe conduits shall be thoroughly cleaned at the time the joint is made.
- E. Rubber Gasket Joints: Rubber gaskets shall conform to the applicable specifications under which the pipe is supplied. Loose gaskets shall be protected from sunlight, contamination and contact with gasoline or fuels.

Rubber gasket joints for water mains consist of our general types:

- 1. Push-on type used for gray or ductile iron, steel and plastic pipe.
- 2. Mechanical type used for gray or ductile iron and fittings for asbestos-cement pipe.
- 3. Rubber and steel joint ring type used for steel cylinder type, reinforced concrete pipe.
- 4. Double rubber gasket couplings used for pressure pipe. Each type, except mechanical, requires the use of a lubricant to facilitate assembly. The lubricant shall be nontoxic, shall not support the growth of bacteria and shall have no deteriorating effects on the gasket. The lubricant shall not impart taste or odor. Care should be taken not to over-use the lubricant since it would then require excess effort to disinfect.

3.5 FIRE HYDRANTS INSTALLATION:

- A. General. Fire hydrants shall be installed as shown on the appurtenance sheets or as directed by the Owner.

- B. Installation. The hydrant shall set truly vertical and be securely braced and blocked on well-compacted or undisturbed soil surrounded by clean gravel or stone (min. of 7 CF) to permit free draining of the hydrant, with the large steam nozzle facing the nearest curb.

3.6 PURGING AND STERILIZATION OF WATER MAINS:

- A. General. Before any newly constructed water main shall be permitted to be placed into service, it shall be purged and tested; or purged, sterilized and tested until the bacterial count within the main meets the Texas Natural Resource Conservation Commission standards.
- B. Procedure. When the entire pipeline or selected sections have been completed, the line or section shall be disinfected according to the following procedures:
 - 1. Pre-sterilization. For convenience in certain locations chlorinated lime (HTH) be placed in the pipe as laid.
 - 2. Sterilization: Sterilization of the main shall be accomplished by the "continuous feed" method or the "slug" method described as follows: The free chlorine amounts shown are minimum. Higher rates may be required by the Engineer. Calcium hypochlorite granules shall be used as the source of chlorine.
 - 3. Continuous Feed Method. If the "continuous feed" method of chlorination is used, the following steps shall be taken:
 - a) Water from the existing distribution system or other approved source of supply shall be made to flow at a constant rate in the newly laid main.
 - b) At a point not more than 10 feet downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine. Chlorine application shall not cease until the entire main is filled with heavily chlorinated water.
 - c) The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. Every effort shall be made to prevent the flow of chlorinated water into mains in active service. At the end of the 24 hour period, the treated water in all portions of the main shall have a residual of at least 10 mg/l free chlorine.
 - d) The heavily chlorinated water shall then be flushed from the main and disposed of in a non-objectionable manner.
 - 4. Slug Method. If the "slug" method of chlorination is used, the following steps shall be taken:
 - a) Water from the existing distribution system or other approved source of supply shall be made to flow at a constant rate in the newly laid main.
 - b) At a point not more than 10 feet downstream from the beginning of the new main, water entering the main shall receive as dose of chlorine such that the water shall have not less than 100 mg/l free chlorine. The chlorine shall be applied continuously and for a sufficient time to develop a solid column or "slug" of chlorinated water that shall expose all interior surfaces to the "slug" for at least three hours.
 - c) As the chlorinated water flows past the fittings and valves, they shall be operated so as to disinfect the appurtenances. Every effort shall be made to prevent the flow of chlorinated water into mains in active service.
 - d) The heavily chlorinated water shall then be flushed from the main and disposed of in a non-objectionable manner.
 - e) Contractor Requirements. The Contractor shall be required, as a minimum, to prepare the main for sterilization and secure same after chlorination is complete. This should include the following:
 - f) In general, this shall consist of furnishing all equipment material and labor to satisfactorily prepare the main for the sterilization method selected. The Contractor

- shall also be required to provide adequate provisions for sampling.
- g) Unless otherwise specified in the special contract documents, the Contractor shall make all necessary taps into the pipe to accomplish chlorination of the new line.
 - h) After satisfactory completion of the sterilization operation, the Contractor shall remove surplus pipe at the chlorination and sampling points, plug the remaining pipe, backfill and complete all appurtenances work necessary to secure the main. Water samples from a suitable tap (not through a fire hydrant) for analysis by the Owner's laboratory, unless otherwise specified in the special provisions or in the plans shall be taken. If the tests show satisfactory quality of water, the line may be placed in service. Unsatisfactory test results shall require a repeat of the disinfection process through retests. The process shall not terminate until a satisfactory sample is obtained.

C. Hydrostatic Test:

- 1. General:
 - a. After pipe has been laid and initial backfill and blocking completed, and while joints and fittings are still exposed, test water lines hydrostatically to a test pressure of 150 psi. Achieve test pressure with compressed air.
 - b. Provide connections, pumps, gauges, meters and other equipment necessary for performance of tests.
- 2. Procedures:
 - a. Before applying specified pressure test, expel all air from the pipe by slowly filling each valved section of pipe with water. Provide taps necessary to expel trapped air.
 - b. Examine all piping, fittings, valves and joints during testing. Fully operate each valve in the test section during testing.
 - c. Test each section for a minimum of 2 hours when joints are exposed, 8 hours when joints are covered.
 - d. Test pipe lines in length between valves or plugs of not more than 1000 feet.
- 3. Maximum Allowable Leakage: Not exceed 12 gallons per inch of pipe diameter per mile of pipe per 24 hours, except replace joints regardless of total leakage quantity where visible leaks occur at exposed joints and where leaks are evident at the surface of joints that are covered.
- 4. Replace defective material with sound material, and repeat test procedures until approved is obtained.

3.7 CLEAN UP:

Upon the completion of the work covered in this Section, the Contractor shall clean up all work areas by removing all debris, surplus material, and equipment from the site. The ground surface shall be restored to its original condition as nearly as possible.

END OF SECTION

SECTION 333100

SANITARY SEWER LINE INSTALLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Work included in this Section, while not all inclusive but listed as a guide, shall include:
 - 1. Furnishing of all labor, tools, equipment and incidentals to complete the work.
 - 2. Layout of the work.
 - 3. Fabrications, construction and installation of sanitary sewer pipe, laterals, manholes, cleanouts and fittings.
 - 4. Testing of completed sanitary sewer line, complete in place with laterals, manholes, cleanouts and fittings.
 - 5. Clean up.

1.2 RELATED SECTIONS:

- A. Coordinate the work of this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the Work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Excavation and Backfill for Conduits - Section 312334
 - 2. Cast in Place Concrete - Section 033000

1.3 REFERENCES:

Meet requirements and recommendations of applicable portions of the Standard listed.

- A. ASTM A48 - Gray Iron Castings.
- B. ASTM C144 - Aggregate for Masonry Mortar.
- C. ASTM C270 - Mortar for Unit Masonry.
- D. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
- E. ASTM D1248 - Polyethylene Plastics Molding and Extrusion Materials.
- F. ASTM D2241 - Poly Vinyl Chloride (PVC) Pressure Rated Pipe (SDR-Series).
- G. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- H. ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- I. ASTM F679 - Poly Vinyl Chloride (PVC), Large Diameter Plastic Gravity Sewer Pipe and Fittings.
- J. American Water Works Association (AWWA): C110 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 inches through 48 inches, for Water and Other Liquids.
- K. AWWA C210 - Liquid Epoxy Coating Systems for Interior and Exterior of Steel Water Pipelines.
- L. North Central Texas Council of Governments Standard Specifications for Public Works Construction, Newest Edition, NCTCOG.
- M. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges, 2014, TxDOT.

PART 2 - PRODUCTS

2.1 Not Used

2.2 POLYVINYL CHLORIDE (PVC) SEWER PIPE & FITTINGS:

- A. General. PVC Sewer Pipe and Fittings shall conform to the current ASTM Designation D 3034, for 4 inch through 15 inch diameter and ASTM designation F 679 for greater than 15 inches diameter. Engineering evaluations of specific installation requirements is recommended.
- B. Pipe Sizes:
 - 1. For pipe sizes 4 through 15 inches in diameter. The pipe shall be Type PSM SDR-35 or SDR-26 as specified in ASTM Designation D 3034.
 - 2. For pipe sizes greater than 15 inch diameter. The pipe shall be Type T-1 and T-2B as specified in ASTM Designation F 679.
- C. Material. The pipe shall be made of PVC plastic having cell classification of 12454-B, 12454-C or 12364-C and fittings shall be made of PVC plastic having cell classifications of 12454-B, 12454-C or 13343-C as defined in ASTM Designation D 1784.
- D. Installation. Pipe produced to this specification shall be installed in accordance with ASTM Designation D 2321. The internal diameter of the installed barrels of the pipe must not be reduced by more than 5% of its base inside diameter when measured not less than 30 days following completion of installation.
- E. Testing. All pipes shall meet ASTM requirements for flattening, impact resistance, stiffness, joint tightness and extrusion quality as specified in ASTM Designation D 3034 and F 679.

2.3 PRECAST REINFORCED MANHOLE SECTIONS:

- A. General: These specifications cover precast reinforced concrete manhole section conforming to precast reinforced concrete manhole sections, ASTM Designation C 478 (C 478M), with the following additions:
 - 1. All pipes shall be machine made by process which shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product, except that reducer cones may be wet-cast.
 - 2. Aggregate for the concrete shall comply with requirements of the current Concrete Aggregates, ASTM Designation C33, with the additional requirement that the aggregate shall have a minimum of 50 percent of calcium carbonate equivalent.
 - 3. Minimum wall thickness for the manhole risers shall be as listed under Wall "B" in the "Class Tables" of ASTM Designation C76 (C76M).
 - 4. Unless otherwise noted, manhole steps shall be furnished. If required, the steps shall be of the plastic or rubber coated steel type, with a clear cleat space of 10 in. (25.4 cm) minimum that shall support a concentrated load of 300 pounds (136.2 kg).
 - 5. Resilient connectors between reinforced concrete manhole structures and pipes shall meet the requirements of ASTM Designation C 923 or ASTM C 443. The resilient connector shall provide an airtight seal with eliminates infiltration and exfiltration.
- B. Joints: Joints shall conform to the joint specification ASTM Designation C 478 (C 478M).
- C. Coatings and lining: Coatings and liners called for in the specifications or indicated on the plans shall meet the requirements for Item 2.12.19. and shall be installed or applied by the manufacturer.
- D. Lifting devices: Manhole sections and cones may be furnished with lift lugs or lift holes. If lift lugs are provided, they shall be 180 degrees apart. Cast-in-place nuts must have clean threads capable of inserting lugs bolts. The lift lug design must be approved by the engineer. If lift holes are provided, they shall be plugged with a nonmetallic nonshrink grout approved by

the engineer. Field repairs shall not be allowed.

- E. Rejection: Manhole sections shall be subject to rejection on account of failure to conform to any of the requirements specified herein or have defects as follows:
1. Variations in any dimensions exceeding the permissible variation prescribed.
 2. A piece broken out of the bell or spigot or tongue or groove in such size that the water tightness of the joint should be impaired.
 3. Any shattering or flaking of concrete or other conditions indicating an improper concrete mix.
 4. Lack of uniformity in placement steel which might preclude all joints being typical of those tested.
 5. Cracks sufficient to impair the strength, durability or serviceability of the pipe.
 6. Joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint.

2.4 PREFORMED FLEXIBLE JOINT SEALANT:

- A. General: This specification covers a cold-applied preformed flexible butyl rubber or plastic sealing compound for sealing interior and/or exterior space on concrete sewer pipe and manhole sections, where infiltration or exfiltration is a factor in the design.
- B. Applicable standards: Except as modified or supplemented herein, all preformed flexible joint sealants shall conform to the applicable requirements of the following standard specifications, latest edition:

<u>Standard</u>	<u>Title</u>
SS - S - 210A	Federal Specification
M198	American Association for State Highway and Transportation Officials (AASHTO)

- C. Basis of acceptance: The acceptability of the preformed flexible joint sealant shall be determined by the results of physical tests, by inspection and by approval of its experience record.
- D. Material: The joint sealer shall be supplied in either extruded rope-form of suitable cross-sectional area or flat-tape form and shall be sized as recommended by the manufacturer and approved by the engineer. The joint sealer shall be protected by a suitable removable wrapper. The joint sealer shall not in any way depend on oxidation, evaporation, or any other chemical action for either its adhesive properties or cohesive strength. The joint sealer shall remain totally flexible without shrinking, hardening, or oxidizing regardless of the length of time it is exposed to the elements. The manufacturer shall furnish an affidavit attesting to the successful use of the product as a preformed flexible joint sealant on concrete pipe and manhole sections for a period of at least five years.
- E. Installation of joint sealant: All surfaces to be in contact with the joint sealant shall be thoroughly cleaned of dirt, sand, mud or other foreign matter. A primer shall be applied to all surfaces prior to installing the joint sealant in accordance with recommendations by the manufacturer. The protective paper wrapper shall remain on the joint sealant until immediately prior to placement of the pipe in the trench. After removal of the protective paper wrapper, the joint sealant shall be kept clean. Backfilling of pipe laid with this joint sealer may proceed after the joint has been inspected by the engineer.
- F. Compliance with specifications: If requested by the engineer, the contractor shall provide results of above specified tests to insure product compliance with these specifications or shall

supply an affidavit of compliance from the manufacturer insuring compliance with these specifications.

- G. Rejection: The preformed flexible joint sealant may be rejected for failure to meet any of the requirements of this specification.

2.5 CASTINGS:

- A. General. Steel and iron castings shall meet the requirements specified herein and on the plans and contract documents.
- B. Steel Castings.
1. High-Strength Steel Castings. High-strength steel castings shall meet the requirements of High-Strength Steel Castings for Structural Purposes, ASTM A 148, Grade as specified.
 2. Mid Steel Castings. Mild steel castings shall meet the requirements of High-Strength Steel Castings for Structural Purposes, ASTM A 14, Grade as specified.
- C. Iron Castings.
1. Material. Casting shall conform to the following ASTM Designations as applicable.

<u>MATERIAL</u>	<u>ASTM</u>	<u>GRADE</u>
Gray Iron Castings	A 48	Class 25 Minimum
Gray Iron Castings for Valves, Flanges, and Pipe Fittings	A126	Class B

2. Workmanship. All casting shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting strength and value for the service intended. Angles shall be filleted, and arises shall be sharp and true.
 3. Coatings. Castings shall be coated with hot or cold applied tar as appropriate.
 4. Rockers and Bearing Plates. Rockers and bearing plates shall be cast iron of the type and grade indicated on the plans and contract documents.
- D. Rejection. Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said metal or material to be unusable for its intended use.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Pipe Handling. All pipe, fittings and specials shall be handled in such a manner as not to damage the material. All dirt and trash shall be removed from the pipe prior to installation. Hooks shall not be permitted. When it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be within the limits provided by the manufacturer.
- B. Stringing of Pipe. Stringing of pipe in advance of the laying operation shall be restricted to one day laying and shall be done in such a manner as to create no hazard or interference with traffic. Ready access shall be provided to all streets, alleys and driveways. The pipe shall be protected with barricades and warning signs at all times. Any damage to the pipe shall be corrected at the expense of the contractor.

- C. Laying Underground Conduit Pipe. Previous to being lowered into the trench, each pipe shall be carefully inspected; and those not meeting specifications shall be rejected and either destroyed or removed from the job. All lumps on the ends of conduit shall be removed before it is lowered into the trench. The pipe and specials shall be so laid in the trench that after the project is completed the interior surface shall conform accurately to the grade and alignment indicated on the plans. Bell holes shall be excavated and all pipe shall be carefully adjusted to fit snugly in cradling or bedding so that the entire length bears on cradling or bedding material with no wedging or blocking to hold up the bell. All pipe shall be laid in the dry, regardless of the type of joint used.

Pipes shall be laid with the bell or groove end up grade and shall be laid with the bell or collar away from the last section placed.

Before laying the pipe, the interior of the joints shall be carefully bored smooth and clean and the annular space shall be kept free from dirt, stones or water. Pipe shall be installed and joints made up in complete conformance with the instructions and recommendations regarding proper installation and assembly furnished by the manufacturer. Proper facilities shall be provided for hoisting and lowering the section of the pipe into the trench without disturbing the prepared foundation and the sides of the trench. All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, standard pipe (short sections of pipe or bevels) shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve.

When work is suspended on the line for any reason, the end of the line shall be properly closed with an effective watertight seal or plug manufactured for this purpose.

- D. Existing Utilities. Pipe capable of supporting its weight approximately at right angles to the ditch shall not require additional support, other than the exercise of care in placing new conduit under same and in placing backfill, except when the span is excessive.

Pipes parallel to and in the edge of cut, shall be supported or rerouted if so indicated on the plans. Utilities parallel to and in edge of cut shall be adequately protected without additional compensation except as set fourth in the contract and proposal.

3.2 INSTALLATION:

- A. Sewer Lateral Connections. Sewer lateral lines shall be constructed as required and shown on the plans.
- B. Sanitary Sewer Joints. When specified in the special provisions or in the plans, a test tee shall be installed at the end of the service line, with the branch in a vertical position.
1. Rubber Gasket Joints. Rubber gaskets shall conform to applicable specifications under which the pipe is supplied. Loose gaskets shall be protected from sunlight, contamination and contact with gasoline or fuels. On pipe for which the gasket is not fixed in place by the manufacturer, the bell-and-spigot or tongue-and-groove shall be thoroughly cleaned by wire brushing and wiping until clean and dry. On pipe which does not require the rubber gasket to be cemented in place, the rubber gasket shall be placed in position on the spigot ring just prior to laying the pipe. The lower edge of the gasket shall be placed under the spigot in the seat and stretched evenly upward on each side to fit over the top of the spigot; and the rubber gasket shall fit snugly and not have uneven tensile stresses. After checking to be sure that the bell-and-spigot are

thoroughly clean, the inside surface of the bell shall be lubricated with a suitable solution (flax soap) to facilitate the telescoping of the joint. Petroleum lubrication shall not be permitted. The spigot end of the pipe shall be entered into the bell of the adjoining pipe and forced into position. Exceptional care shall be taken in making the field joint. Bumping of the pipe shall not be permitted. On small pipe, if the bottom of the trench is firm enough, a bar having a blade on the end may be pushed into the ground, then the bar may be used as a level to push the pipe home. However, if trench conditions are too unstable, or are in rock, it shall be necessary to use mechanical means to bring the pipe together positively. Each joint shall be partially backfilled or suitably blocked to prevent creeping. Unless otherwise specified in the special provisions or in the plans, for all sizes of concrete pipe larger than 24 inches (.6M) in diameter, the inside annular space provided for that purpose shall be completely filled with a plastic portland cement mortar (composed of 1 part cement to 2 1/2 parts sand); or preformed flexible joint sealant in rope form; or troweling type. Where the pipe has been corrosion protected, and an annular space is open, only the bottom half of the inside annular space shall be filled with mortar; and a ready-mix cold-pour compound shall be used in the upper half, as hereinbefore described, that is resistant to acid, alkalis, and gases and is compatible with rubber. The joint shall be finished smoothly and all surface materials removed.

2. Chemically Welded Joints. The joint materials shall conform to the applicable specifications under which the pipe is supplied. The joint shall be installed per recommendations of the manufacturer. The ditch embedment should be to grade, with the advance bell hole scooped out prior to laying so that the pipe shall be to grade as the joint is made.
3. Compression Joints. The joint materials shall conform to the applicable specifications under which the pipe is supplied. The bells and spigots must be thoroughly clean. Extreme care must be exercised to prevent damage to the joint. The spigot end shall be inserted into the bell and pushed home after a suitable lubricant, as recommended by the pipe manufacturer, is applied. Petroleum lubrication shall not be permitted. The ditch embedment should be to grade, with the advance bell hole scooped out prior to laying so that the pipe should be to grade as the joint is made.

3.3 TESTING AND INSPECTION:

In order to ascertain that the main shall perform the function for which it was designed and constructed, performance tests shall be routinely executed. Tests can be made by one of two methods. Infiltration or exfiltration tests may be made on sections as they are completed to assure that performance is satisfactory. Manholes shall be tested by infiltration or exfiltration. Tunneled, bored or jacked sections of all pipes shall be tested by exfiltration only. Testing shall be performed by the contractor in the presence of the owner's representative after all backfilling and compaction are complete. All sections between manholes or between a manhole and a dead end shall be tested separately. In the making of all tests, the contractor shall furnish the required equipment and labor. Tests may be repeated until each sewer individually meets the specifications as to quantity of allowable infiltration or exfiltration as set out below. All testing work shall be included in the bid price.

- A. Infiltration Test. The total seepage in infiltration of ground water as determined by test shall in no case exceed 50 gallons per inch of normal diameter of pipe per mile (0.2 cubic meters per centimeter of nominal diameter per kilometer) over a 24-hour period; and shall be the same regardless of piping material used. The allowable leakage of each manhole, or other structure, shall be as specified on the plans. An infiltration test or tests shall be made on all sections of the project where air testing could not be adequately performed and on each manhole individually before placing the system in service and before any connections are made to other sewers. If the quantity of the effluent into the sewer or sewers is in excess of the maximum

quantity as hereinafter specified, the joints shall be repaired or the sewer relayed, if necessary, or other remedial construction shall be performed by and at the expense of the contractor, in order to reduce the quantity of ground water infiltration to an amount within limits as specified. The test shall be made by utilizing ground water, if any, or flooding a section at a time. Observation from jetting is not acceptable.

1. Using Existing High Ground Water. Where the natural ground water, after well points are removed, is above the top of the pipe for a section, the flowing of water in the pipe and the rate of seepage and infiltration for the section so submerged can be measured.
 2. Flooding By Sections. Backfill shall be brought up to at least a foot (30cm) over the pipe on the section to be tested. More cover may be required on larger pipes to prevent the pipe from floating out of grade. Dams or dikes are placed tightly around pipe at either end and the ditch filled with water to an average depth of four feet (1.2M) over the pipe. Flow at the lower end is measured for the section so submerged. Dikes shall be placed around each manhole; and the area adjacent to the manhole shall be flooded to the top of the manhole and the flow into the manhole measured.
 3. Flushing or Jetting of Backfill. During jetting to settle the backfill, the flow at the lower manhole shall provide a control indication of possible infiltration which should be corrected.
- B. Exfiltration. A section of pipe below a manhole is bulkheaded at either end with a 6" (15cm) pipe inserted into lower bulkhead and by use of a 90-degree bend. The 6" (15cm) pipe is set in a vertical position. A 2" (5cm) vent pipe is inserted in lower end and extended upward four feet (1.2M). The 6" (15cm) pipe is filled with water, filling the sewer line until all air is forced out through the vent tube. When the water levels are level in the 2" (.5cm) and 6" (15cm) pipes, the drop in the 6" pipes (15cm) due to exfiltration over a specific time shall be measured and the loss of water due to exfiltration calculated. This amount shall be reduced by 25 percent to obtain equivalent infiltration over a specific time and the loss of water due to exfiltration calculated. Conditions encountered in construction may vary this procedure slightly, but essentially this method shall be used.

3.4 SEWER APPURTENANCES:

- A. Description. This section shall govern for the construction of all miscellaneous sanitary sewer structure such as junctions, transitions, special concrete manholes, creek crossings, river crossings and utility supports; and for the construction of appurtenances such as manholes, cleanouts, deep-cut connections, wyes, stoppers and bulkheads, fittings and such other miscellaneous structures or appurtenances which may be shown on the plans.
- B. Connections of pipe sewer to existing sewers or sewer appurtenances shall be as shown on the plans or as directed by the engineer. Connections shall be made to prevent the occurrence of bi-metallic corrosion or any other corrosion that can result by joining incompatible materials. The bottom of the existing structure shall be mortared or concreted if necessary, to eliminate any drainage pockets by the new connection, and in general accord with details for the new structure as shown on the plans. Where the sewer is connected into old structures which are to remain in service, any damage to the structure resulting from the work of making the connection shall be restored by the contractor to the satisfaction of the engineer.
- C. Creek Crossings. Creek crossings using pier construction shall be made in accordance with the details shown on the plans.
- D. Laterals. Laterals shall be located as indicated on the plans or as directed by the engineer. Details of construction shall be as shown on the plans.

The lateral shall be of the same pipe material as the main.

Laterals to property shall be marked under the ground surface by placing green metallic plastic tape with the word "SEWER" printed on the tape at regular intervals. One end of the tape shall be placed at the end of the lateral; the other end shall be just under the ground surface projecting at least one foot (30 cm) back of the proposed or existing curb.

3.5 MANHOLES:

Sanitary sewer manholes shall be fabricated in different configurations to meet with specific needs required in the sanitary sewer system.

- A. General. Unless otherwise specified, manholes shall have an inside diameter of four feet (1.2 M). Manholes constructed in advance of paving projects shall be constructed with the top of the concrete portion of the manhole 23 inches below the final finished grade. The ring and cover shall be placed on a built-up section of brick and mortar. Manholes shall be watertight. The type and size, if other than four feet inside diameter, shall be shown on the plans for each location.
 - 1. Cast-In-Place. The base, wall and cone shall be Type 1 concrete poured and vibrated to assure a monolithic structure. Construction joints with waterstops must be approved by the engineer.
 - 2. Precast. The base shall be 3600 psi concrete. The precast sections shall be of the bell-and-spigot design incorporating tapped O-ring gaskets, or tongue-and-groove with premolded joint sealing compound. Lift holes may be used but must be filled with nonshrink grout after the section is in place. Combination of joints shall be selected to minimize the number of individual segments. Long joints shall be used in the bottom and shorter segments utilized for top adjustments.
 - 3. Drop. Drop manholes shall be constructed in accordance with details on the plans. The construction is the same as that for a cast-in-place manhole with special provisions incorporated to provide drop piping.
 - 4. Steps, Rings and Covers. Installation of steps, rings and covers shall be shown on the plans. Manhole steps shall only be used if specified on the plans or in the contract document. Where manhole steps are not used, the contractor shall furnish a ladder for access for inspection. Manhole covers shall be detailed on the plans.
- B. Special Requirements.
 - 1.
 - (a) Flow Channel. When specified in the special provisions or in the plans, the sanitary sewer pipe shall be laid through the manhole stations where possible, prior to concreting, so that the full depth of the pipe is embedded in concrete to form the flow channel.
 - (b) Flow Channel Alternate. Where pipe cannot be used through the manhole due to intersecting flow channels, flow channels equivalent to the top of pipe shall be formed with concrete then trowel to a smooth, even finish with a steel trowel.
 - (c) Manhole Bottom. The manhole bottom from wall line to flow channels shall be sloped and troweled smooth on a grade of one inch per foot (2.5cm per 30cm) with a liberal radius applied at flow channel intercepts.

2. First Full Joint. The first full joint of pipe extending from the manhole shall be cradled in concrete to the pipe joint in the same pour as that for the manhole base slab as shown on the plans.
3. Pick Slots. For all manhole installations in the streets, the manhole covers shall be provided with pick slots in lieu of pick holes. If the rim elevation above surrounding ground is prohibited by land use or other reasons, a cover with a pick slot as described for use in street locations shall be used.

3.6 CLEANOUTS:

- A. Construction Methods. Cleanouts shall be constructed in accordance with the plans and these specifications for materials and construction.

END OF SECTION

SECTION 334100

STORM SEWER LINE INSTALLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work included in this Section, while not all inclusive but listed as a guide, shall include:
 - 1. Furnishings of all labor, tools, equipment and incidentals to complete work.
 - 2. Layout of the work.
 - 3. Installation of atrium drains, culverts, and appurtenances including head walls.
 - 4. Trench safety.
 - 5. Testing.
 - 6. Clean up.

1.2 RELATED SECTIONS

- A. Coordinate the work in this Section with the Work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the Work of other Sections. Other Sections containing related work include but are not limited to the following:
 - 1. Excavation and Backfill for Conduits - Section 312334

1.3 REFERENCES

Meet requirements and recommendations of applicable portions of the Standard listed.

- A. ASTM C76 - Reinforced Concrete Storm Drain and Sewer Pipe.
- B. ASTM D1784 - Rigid Polyvinyl (PVC) Compounds and Chlorinated Polyvinyl (CPVC) Compounds.
- C. ASTM D3350 - Polyethylene Plastics Pipe and Fittings
- D. ASTM D1785 - Plastic Pipe, Schedules 40, 80 and 120.
- E. Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges, 2014 TxDOT.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Section 013300.
- B. Pipe Certifications: Manufacturers certification that pipe or precast units meets the requirement of these specifications.

1.5 PROJECT CONDITIONS

- A. Verify that storm sewerage system piping may be installed in compliance with original design and referenced standards.
- B. Locate existing storm sewerage piping and structures that are to be abandoned and closed.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. General. Provide pipe and pipe fitting materials compatible with each other and as indicate on the drawings. Where more than one type of materials or product is indicated, selection is installers option.
- B. PVC Sewer Pipe and Fittings for sizes 4 thru 15 inches in diameter are SDR26: ASTM D 3034, SDR 35, for solvent cement or elastomeric gasket joints.
 - 1. Solvent Cement: ASTM D 2564.
 - 2. Gasket: ASTM 477, elastomeric seal.
- C. PVC Sewer Pipe and Fittings for sizes greater than 15 inches in diameter: ASTM F 679, T-1A or T-1B wall thickness, bell and spigot, for elastomeric gasket joints.
- D. Reinforced Concrete Sewer Pipe and Fittings: ASTM C 76 of the class shown on the plans.
- E. HDEP Storm Sewer Pipe and Fittings: ASTM D 3350

2.2 MANHOLES

- A. Precast Concrete Manholes: ASTM C 478, precast reinforced concrete, of depth indicated with provision for rubber gasket joints.
 - 1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having a separate base slab or base section with integral floor.
 - 2. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 - 3. Top Section: Eccentric cone type, unless concentric cone or flat-slab-top type is indicated. Top of cone to match grade rings.
 - 4. Grade Rings: Provide 2 or 3 reinforced concrete rings, of 6 to 9 inches total thickness and match 24-inch diameter frame and cover.
 - 5. Gaskets: ASTM C 443, rubber.
 - 6. Steps: Cast into base, riser, and top sections sidewall at 12 to 16 inch intervals.
 - 7. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
 - 8. Channel and Bench: Concrete.
- B. Cast-in-Place Manholes: Reinforced concrete of dimensions and with appurtenances indicated.
 - 1. Bottom, Walls and Top: Reinforced concrete.
 - 2. Channel and Bench: Concrete.
 - 3. Steps: Cast into sidewall at 12 to 16-inch intervals.
- C. Manholes Steps: Wide enough for an adult to place both feet on one step and designed to prevent lateral slippage off the step. Material shall be steel-reinforced plastic.
- D. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy duty, ductile iron, 24-inch inside diameter by 7 to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover, indented top design, with lettering STORM SEWER cast into cover.

2.3 CATCH BASINS

- A. Precast Concrete Catch Basins: ASTM C 478 or ASTM C 858, precast reinforced concrete, of

depth indicated. Sections shall have provisions for rubber gasket joints. Base section slab shall have minimum thickness of 6 inches, riser sections shall have minimum thickness of 4 inches and be 48 inches inside diameter, and top section and grade rings shall match 24-inch frame and grate, unless otherwise indicated.

1. Base Section: Base riser section and separate and base slab, or base riser section with integral floor.
 2. Riser Sections: Sections shall be of lengths to provide depth indicated.
 3. Top Section: Flat slab type with opening to match grade rings.
 4. Grade Rings: Provide 2 or 3 reinforced concrete rings, of 6 to 9 inches total thickness.
 5. Gaskets: ASTM C 443, rubber.
 6. Step: Cast into riser sidewall at 12 to 16-inc intervals.
 7. Pipe connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.
 8. Channel and Bench: Concrete.
- B. Cast-in-Place Catch Basins: Reinforced concrete of dimensions and with appurtenances indicated.
1. Bottom, Walls and Top: Reinforced concrete.
 2. Channel and Bench: Concrete.

- C. Curb Inlets: Precast concrete, brick or other materials, of dimensions conforming to the plans.

2.4 JOINTING MATERIALS

Unless otherwise specified on the plans the Contractor shall have the option of making the joints using any of the materials described herein. For all jointing materials except mortar, the Contractor shall furnish by the Manufacturers Certificate of Compliance.

- A. Mortar: Mortar shall consist of one (1) part cement, two (2) parts sand and sufficient water to make a plastic mix.
- B. Cold Applied, Plastic Asphalt Sewer Joint Compound. This material shall consist of natural and/or processed asphalt base, suitable volatile solvents and inert filler. The consistency is to be such that the ends of the pipe can be coated with a layer of the compound up to one-half inch thick by means of a trowel. The joint compound shall cure to a firm, stiff plastic condition after application. The material shall be of a uniform mixture and any small separation occurring in the container shall be stirred to a uniform mix before use.

This material shall meet the following requirements when tested in accordance with Test Method Tex-5267-C:

Asphalt Base, 100% - % Volatiles -	
% Ash, % by weight.....	28-45
Volatiles, 212 F Evaporation, 24 h,	
% by weight.....	10-26
Mineral Matter, determined as Ash,	
% by weight.....	30-55
Consistency, Cone Penetration,	
150 q, 5 sec, 77F.....	150-275

- C. Rubber Gaskets: These gaskets shall conform to ASTM C361 or C443. The design of the joints and permissible variations in dimensions shall be in accordance with ASTM C443. The Contractor shall furnish by the Manufacturer's Certificate of Analysis
- D. Cold Applied Preformed Plastic Gaskets. Preformed plastic gaskets shall be suitable for

sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength, and shall be supplied in extruded rope-form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and be of sufficient size to properly seal the joint. The plastic gasket joint sealer shall be so constructed as to provide evidence of proper installation either by means of "squeeze-out" of the gasket material on the inside or outside around the complete pipe joint circumference or by means of tabs, projections or other such indicators placed at established intervals around the circumference of the pipe joint. Plastic gasket joint sealers shall be Type 1 or Type 2. Type 1 gaskets shall meet the "squeeze-out" requirements and Type 2 gaskets shall meet the requirements for tabs, projections or other indicators. The gasket joint sealer shall be protected by a suitable wrapper designed that when removed, the jointing material maintains integrity.

The chemical composition of the gasket joint sealing compound for Type 1 and 2, as shipped, shall meet the following requirements:

<u>COMPOSITION TEST</u>	<u>METHOD</u>	<u>ANALYSIS</u>
Bitumen, Petroleum Plastic Content % by weight	ASTM D4	50-70
Ash-Inert Mineral Matter % by weight	Tex-526-C	30-50
Volatile Matter, 325 F, % by weight	Tex-506-C	2.0 max.

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in five (5) percent solution of caustic potash; a five (5) percent solution of caustic potash; a five (5) percent solution of hydrochloric acid; a five (5) percent solution of sulfuric acid; and a saturated H-S solution, shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

<u>PROPERTY REQUIREMENT</u>	<u>TEST METHOD</u>	<u>TYPE 1</u>	<u>TYPE 2</u>
Ductility @ 77 F (cm), min.	Tex-503-C	5.0	5.0
Softening Point °F	Tex-503-C	275	275
<u>Penetration:</u>			
32°F (300g) 60 sec., min.	Tex-502-C	--	65
77°F (150g) 5 sec.	Tex-502-C	50-120	50-120
115°F (150g) 5 sec., max.	Tex-502-C	--	150

- E. Construction Methods: The location of private driveway and side road pipe shall be constructed at locations shown on the plans. Reinforced concrete pipe culverts and sewers shall be constructed in accordance with the plans and requirements of this Item.
- F. Excavation. All excavation shall be in accordance with the requirements of Section 02316, Excavation and Backfill for Conduits, except where tunneling or jacking methods are shown on the plans.

2.5 OUTFALLS

- A. General: Construct of cast-in-place reinforced concrete pipe, head wall, apron, tapered sides, and with rip rap, as indicated.

2.6 CONCRETE AND REINFORCEMENT

- A. Concrete: Portland cement mix, 3,000 psi., ASTM C94, Ready-Mixed concrete.
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: potable.
- B. Reinforcement : Steel conforming to the following:
 - 1. Fabric: ASTM A 185, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615, Grade 60, deformed.

PART 3 - EXECUTION

3.1 PREPARATION OF FOUNDATION FOR BURIED STORM SEWERAGE SYSTEMS

- A. Grade trench bottom to provide a smooth, firm, stable and rock-free foundation, throughout the length of the pipe.
- B. Remove unstable, soft and unsuitable materials at the surface upon which pipes are to be laid, and backfill with bedding material to indicated level.
- C. Provide embedment as shown on the plans.
- D. Shape bottom of trench to fit bottom of pipe. Fill unevenness with tamped bedding material. Dig bell holes at each pipe joint to relieve the bells of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

3.2 GENERAL INSTALLATION

- A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of the underground storm sewerage system piping. Location and arrangement of piping layout take into account many design considerations, install the piping as indicated, to the extent practical.
- B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves and couplings in accordance with manufacturers recommendations for use of lubricants, cements and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- C. Use manholes or catch basins for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.
- E. Extend storm sewerage system piping to connect to building storm drains, of sizes and in locations indicated.
- F. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling,

jacking or a combination of both.

3.3 PIPE AND TUBE JOINT CONSTRUCTION AND INSTALLATION

- A. Join and install PVC pipe as follows:
 - 1. Solvent cement joint pipe and fittings, joining with solvent cement in accordance with ASTM D 2855 and ASTM F 402.
 - 2. Pipe and gasketed fittings, joining with elastomeric seals in accordance with ASTM D 3212.
 - 3. Installation in accordance with ASTM D 2321.
- B. Join concrete pipe and fittings with rubber gaskets in accordance with ASTM C 443, and install piping in accordance with applicable provisions of ACPA Concrete Pipe Installation Manual.
- C. Join different types of pipe with standard manufactured couplings and fittings intended for that purpose.

3.4 MANHOLES

- A. General: Install manholes complete with accessories as indicated. Form continuous concrete or split pipe section channel and benches between inlets and outlets. Set tops of frames and covers flush with finish surface where manholes occur in pavements. Elsewhere, set tops 3 inches above finish surface, unless otherwise indicated.
- B. Place precast concrete manhole sections as indicated and install in accordance with ASTM C 891.
- C. Construct cast-in-place manholes as indicated.
- D. Provide rubber joint gasket complying with ASTM C 443 at joint of sections.
- E. Apply bituminous mastic coating at joints of sections.

3.5 CATCH BASINS

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.6 OUTFALLS

- A. Construct outfalls of the type and material as indicated on the plans.

3.7 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirement specified for new work.
- B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of 3000-psi 28 day compressive strength concrete.
- C. Make branch connections from side into existing 24-inch or larger piping or to underground structures by cutting opening into existing unit sufficiently large to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or

structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

1. Provide concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
2. Use epoxy bonding compound as interface between new and existing concrete and piping materials.

- D. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous materials that may accumulate.

3.8 CLOSING ABANDONED STORM, SEWERAGE SYSTEM

- A. Abandoned Piping: Close open ends of abandoned underground piping that is indicated to remain in place. Provide sufficiently strong closures to withstand hydrostatic or earth pressure that may result after ends of abandoned utilities have been closed.

1. Close open ends of concrete or masonry utilities with not less than 8-inch-thick brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Wood plugs are not acceptable.

- B. Abandoned Structures: Remove structure and close open ends of the remaining piping or remove top of structure down to not less than 3 feet below final grade; fill structure with stone, rubble, gravel or compacted dirt, to within 1 foot of top of structure remaining and fill with concrete.

3.9 FIELD QUALITY CONTROL

- A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.
3. Flush piping between manholes, if required by local authority, to remove collected debris.

- B. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.

1. Make inspections after pipe between manholes and manhole locations has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, correct such defects and inspect.

END OF SECTION