

Project Manual for PNC MO Lee's Summit Ground-Up Branch

CONSTRUCTION DOCUMENTS



PROJECT ADDRESS:

WEST PRYOR DEVELOPMENT, LOT 9A
NEW PRYOR RD. & NW SUMMIT WOODS XING
LEE'S SUMMIT, MO 64081

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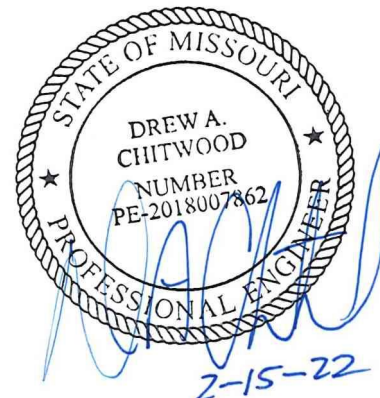
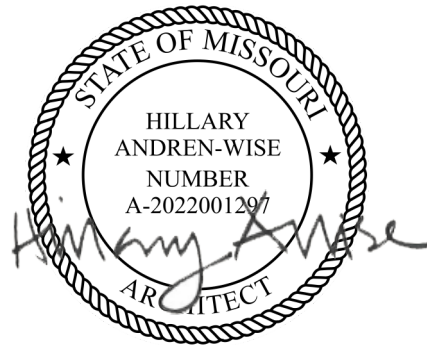
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PROJECT ARCHITECT - ENGINEER

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A/E PROJECT:

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Division	Section Title	Revision Date	Pages
SPECIFICATIONS GROUP			
DIVISION 03 – CONCRETE			
03 30 00	CAST-IN-PLACE CONCRETE	01/27/2022.....	10
DIVISION 04 – MASONRY			
04 22 00	CONCRETE UNIT MASONRY	01/27/2022.....	13
DIVISION 05 - METALS			
05 12 00	STRUCTURAL STEEL FRAMING	01/27/2022.....	5
05 21 00	STEEL JOIST FRAMING	01/27/2022.....	3
05 31 00	STEEL DECKING.....	01/27/2022.....	4
05 40 00	COLD-FORMED METAL FRAMING.....	01/27/2022.....	7
05 52 13	PIPE AND TUBE RAILINGS.....	01/27/2022.....	5
DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES			
06 10 53	MISCELLANEOUS ROUGH CARPENTRY.....	01/27/2022.....	7
06 16 00	SHEATHING.....	01/27/2022.....	4
06 40 23	INTERIOR ARCHITECTURAL WOODWORK	01/27/2022.....	6
06 41 16	PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS	01/27/2022.....	9
DIVISION 07 - THERMAL AND MOISTURE PROTECTION			
07 13 26	SELF-ADHERING SHEET WATERPROOFING.....	01/27/2022.....	5
07 14 16	COLD FLUID-APPLIED WATERPROOFING	01/27/2022.....	4
07 21 00	THERMAL INSULATION	01/27/2022.....	5
07 27 13	MODIFIED BITUMINOUS SHEET AIR BARRIERS	01/27/2022.....	6
07 46 46	FIBER-CEMENT SIDING	01/27/2022.....	4
07 54 23	THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING.....	01/27/2022.....	11
07 62 00	SHEET METAL FLASHING AND TRIM	01/27/2022.....	9
07 71 00	ROOF SPECIALTIES	01/27/2022.....	7
07 72 00	ROOF ACCESSORIES	01/27/2022.....	6
07 92 00	JOINT SEALANTS	01/27/2022.....	9
DIVISION 08 - OPENINGS			
08 11 13	HOLLOW METAL DOORS AND FRAMES.....	01/27/2022.....	8
08 31 13	ACCESS DOORS AND FRAMES	01/27/2022.....	3
08 41 13	ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS	01/27/2022.....	13
08 42 29.23	SLIDING AUTOMATIC ENTRANCES	01/27/2022.....	13

08 71 00	DOOR HARDWARE	01/27/2022.....	11
08 80 00	GLAZING	01/27/2022.....	10
DIVISION 09 - FINISHES			
09 22 16	NON-STRUCTURAL METAL FRAMING	01/27/2022.....	8
09 29 00	GYPSUM BOARD	01/27/2022.....	8
09 30 13	CERAMIC TILING	01/27/2022.....	8
09 51 23	ACOUSTICAL TILE CEILINGS.....	01/27/2022.....	6
09 65 13	RESILIENT BASE AND ACCESSORIES	01/27/2022.....	4
09 65 19	RESILIENT TILE FLOORING.....	01/27/2022.....	5
09 65 36	STATIC-CONTROL RESILIENT FLOORING	01/27/2022.....	6
09 68 13	TILE CARPETING.....	01/27/2022.....	5
09 72 00	WALL COVERINGS	01/27/2022.....	3
09 77 13	STRETCHED-FABRIC WALL SYSTEMS	01/27/2022.....	6
09 91 23	INTERIOR PAINTING	01/27/2022.....	6
DIVISION 10 - SPECIALTIES			
10 28 00	TOILET ACCESSORIES	01/27/2022.....	3
10 44 00	FIRE PROTECTION SPECIALTIES.....	01/27/2022.....	6
DIVISION 12 - FURNISHINGS			
12 24 13	ROLLER WINDOW SHADES	01/27/2022.....	3
12 36 61.16	SOLID SURFACING COUNTERTOPS.....	01/27/2022.....	3
DIVISION 22 - PLUMBING			
22 01 30	CLEANING AND TESTING	01/27/2022.....	2
22 05 00	BASIC MECHANICAL MATERIALS AND METHODS.....	01/27/2022.....	20
22 05 23	VALVES (PLUMBING)	01/27/2022.....	7
22 05 29	PLUMBING SYSTEMS HANGERS AND SUPPORTS.....	01/27/2022.....	9
22 05 53	PLUMBING IDENTIFICATION	01/27/2022.....	6
22 07 00	PIPE INSULATION	01/27/2022.....	16
22 08 00	COMMISSIONING OF PLUMBING	01/27/2022.....	6
22 11 16	DOMESTIC WATER PIPING	01/27/2022.....	8
22 11 19	PLUMBING SPECIALTIES	01/27/2022.....	9
22 11 22	METERS AND GAGES	01/27/2022.....	7
22 13 16	SANITARY WASTE AND VENT PIPING.....	01/27/2022.....	8
22 33 00	ELECTRIC DOMESTIC WATER HEATERS	01/27/2022.....	6
22 40 00	PLUMBING FIXTURES.....	01/27/2022.....	6
DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)			
23 05 00	BASIC MECHANICAL MATERIALS AND METHODS.....	01/27/2022.....	23
23 05 13	MOTORS	01/27/2022.....	4

23 05 29	HANGERS AND SUPPORTS	01/27/2022.....	9
23 05 48	MECHANICAL VIBRATION CONTROLS AND SEISMIC RESTRAINTS	01/27/2022.....	5
23 05 48	MECHANICAL IDENTIFICATION	01/27/2022.....	6
23 05 93	TESTING, ADJUSTING, AND BALANCING	01/27/2022.....	17
23 07 00	DUCT INSULATION.....	01/27/2022.....	14
23 07 19	HVAC PIPING INSULATION	01/27/2022.....	16
23 08 00	COMMISSIONING OF HVAC.....	01/27/2022.....	9
23 23 00	REFRIGERANT PIPING	01/27/2022.....	10
23 29 13	MOTOR CONTROLLERS.....	01/27/2022.....	5
23 31 13	METAL DUCTS.....	01/27/2022.....	17
23 33 00	DUCT ACCESSORIES	01/27/2022.....	11
23 34 23	POWER VENTILATORS	01/27/2022.....	8
23 37 13	DIFFUSERS, REGISTERS, AND GRILLES	01/27/2022.....	3
23 74 13	ROOFTOP UNITS (DX)	01/27/2022.....	13
23 81 26	SPLIT-SYSTEM AIR-CONDITIONING UNITS.....	01/27/2022.....	5
DIVISION 26 - ELECTRICAL			
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL.....	01/27/2022.....	12
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	01/27/2022.....	5
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	01/27/2022.....	5
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	01/27/2022.....	4
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.....	01/27/2022.....	9
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS.....	01/27/2022.....	5
26 09 23	LIGHTING CONTROL DEVICES	01/27/2022.....	4
26 24 16	PANELBOARDS.....	01/27/2022.....	6
26 27 13	ELECTRICITY METERING	01/27/2022.....	3
26 27 26	WIRING DEVICES	01/27/2022.....	7
26 28 16	ENCLOSED SWITCHES AND CIRCUIT BREAKERS	01/27/2022.....	4
26 36 00	TRANSFER SWITCHES	01/27/2022.....	4
26 43 13	TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS	01/27/2022.....	3
26 51 19	LED INTERIOR LIGHTING	01/27/2022.....	8
26 52 13	EMERGENCY AND EXIT LIGHTING	01/27/2022.....	8

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

END OF TABLE OF CONTENTS

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Sections:
 - 1. Section 01 81 13 "Sustainable Design Requirements" for additional LEED requirements.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Documentation Submittals:
 - 1. Comply with submittal requirements of Division 01 Section "Sustainable Design Requirements" including, but not limited to:
 - a. LEED Criteria Worksheet.
 - b. FSC Certified Wood Information.
 - c. Recycled Content Information.
 - d. Regional Materials Information.
 - e. LEED Materials and Resources Calculator.
- C. Design Mixtures: For each concrete mixture.
- D. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.

1.4 QUALITY ASSURANCE

- A. 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."
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.5 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1.
 1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 1. ACI 301 (ACI 301M).
 2. ACI 117 (ACI 117M).

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- 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.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- D. 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."

2.4 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I/II.
2. Fly Ash: ASTM C 618, Class F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.

1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do 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.

E. Water: ASTM C 94/C 94M and potable.

2.5 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Fortifiber Building Systems Group; Moistop Ultra 10
2. W.R. Meadows, Inc.; Perminator 10 mil.
3. Raven Industries, Inc.; Vapor Block 10.
4. Reef Industries, Inc.; Griffolyn 10 mil.
5. Stego Industries, LLC; Stego Wrap 10 mil. Class A

2.6 CURING MATERIALS

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

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) 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.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.7 RELATED MATERIALS

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

2.8 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 (ACI 301M).
- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Normal-Weight Concrete:
 - 1. Minimum Compressive Strength: As indicated on plan at 28 days.
 - 2. Maximum W/C Ratio: 0.50.
 - 3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
 - 4. Air Content:
 - a. Foundations and Tie beams: 4.5 percent, plus or minus 1.5 percent at point of placement.
 - b. Slab-on-Grade: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.10 FABRICATING REINFORCEMENT

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

2.11 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. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 (ACI 301M), 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 (ACI 117M).
- C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEM INSTALLATION

- 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.

3.3 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 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.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is 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. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).

3.7 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 or to be covered with a coating or covering material applied directly to concrete.

- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 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. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
 - 1. Apply scratch finish to surfaces to receive concrete floor toppings or to receive mortar setting beds for bonded cementitious floor finishes.
- 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 and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- 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 or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
- E. Nonslip Broom Finish: Apply a broom finish to exterior concrete platforms, steps, 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.

3.9 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 (1 kg/sq. m 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 remainder of curing period.
- D. 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.
 - 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 (300 mm), 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.
 - 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. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
 - 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.

3.10 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.11 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M 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 provides 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/C 231M, 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 or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure **two** sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. 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.
11. Test results shall be reported in writing to Engineer, 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.
12. 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.
13. 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 Engineer. 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.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000

SECTION 04 22 00 – CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.

B. Related Sections:

1. Section 01 81 13 "Sustainable Design Requirements" for additional LEED requirements.

1.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Documentation Submittals:

1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
2. Recycled Content: Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include data on material properties material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 3. Mortar admixtures.
 - 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 5. Grout mixes. Include description of type and proportions of ingredients.
 - 6. Reinforcing bars.
 - 7. Joint reinforcement.
 - 8. Anchors, ties, and metal accessories.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- D. 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 TMS 602/ACI 530.1/ASCE 6.
- E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

1.7 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. Store preblended, dry mortar mix in delivery containers on elevated platforms 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.

1.8 FIELD 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.
- B. Do not apply uniform 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 comes 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.
 - 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 TMS 602/ACI 530.1/ASCE 6.
 - 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 TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
 - 2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet vertically and horizontally of a walking surface.

2.4 CONCRETE MASONRY UNITS

- A. 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.
- B. CMUs: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
 - 2. Density Classification: Normal weight unless otherwise indicated.
 - 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.
5. Faces to Receive Stucco: Where units are indicated to receive a direct application of stucco, provide textured-face units made with gap-graded aggregates.

2.5 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following:
- B. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars required or indicated.
- C. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, 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.

2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, 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.
 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91/C 91M.
- E. Mortar Cement: ASTM C 1329/C 1329M.
- F. 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.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C 404.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to 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.
- C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951/A 951M.
 - 1. Interior Walls: Hot-dip galvanized carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized carbon steel.
 - 3. Wire Size for Side Rods: 0.148-inch diameter.
 - 4. Wire Size for Cross Rods: 0.148-inch diameter.
 - 5. Spacing of Cross Rods: Not more than 16 inches o.c.
 - 6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.
- B. 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/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
 - 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 - 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.9 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 or mortar cement mortar unless otherwise indicated.
 - 3. For exterior masonry, use portland cement-lime masonry cement or mortar cement mortar.
 - 4. For reinforced masonry, use portland cement-lime masonry cement or mortar cement mortar.
 - 5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- 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, Proportion 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 S.
 - 2. For reinforced masonry, use Type S.
 - 3. For mortar parge coats, use Type S or Type N.
 - 4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 - 5. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. 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 TMS 602/ACI 530.1/ASCE 6 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/C 143M.

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 the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. 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.

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 1/8 inch in 10 feet, 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 1/4 inch in 10 feet, 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 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 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.

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 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 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.

3.4 LAYING MASONRY WALLS

- #### A.
- 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.

- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 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.
- D. Stopping and Resuming Work: Stop work by stepping 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.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. 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.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. 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.
 - 3. Wedge nonload-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.
 - 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

- C. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c.
 - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

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 as follows 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.

3.8 LINTELS

- A. Provide concrete or masonry lintels where shown and 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.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 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 TMS 602/ACI 530.1/ASCE 6.
- 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 TMS 602/ACI 530.1/ASCE 6 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.

3.10 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Engage approved 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: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.
 - 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. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
- I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.11 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.12 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. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. 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 nonmasonry 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 concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.13 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. Masonry Waste: Remove excess masonry waste and legally dispose of off Owner's property.

END OF SECTION 04 22 00

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Requirements:

1. Section 01 81 13 "Sustainable Design Requirements" for additional LEED requirements.

1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. LEED Documentation Submittals:

1. Comply with submittal requirements of Division 01 Section "Sustainable Design Requirements" including, but not limited to:
 - a. LEED Criteria Worksheet.
 - b. Recycled Content Information.
 - c. Regional Materials Information.
 - d. LEED Materials and Resources Calculator.

- C. Shop Drawings: Show fabrication of structural-steel components.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, and testing agency.
- B. Welding certificates.
- C. Mill test reports for structural steel, including chemical and physical properties.
- D. Source quality-control reports.

- E. Field quality-control and special inspection reports.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 360.
 - 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992/A 992M.
- B. Channels, Angles: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C, structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
- B. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
 - 1. Configuration: Straight.
 - 2. Finish: Plain.
- C. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Finish: Plain.

D. Threaded Rods: ASTM A 36/A 36M.

1. Finish: Plain.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

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.

- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

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 of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Surfaces enclosed in interior construction.

- 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 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 minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 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 plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and 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.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

3.3 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.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 1. Verify structural-steel materials and inspect steel frame joint details.
 2. Verify weld materials and inspect welds.
 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Bolted Connections: Visually inspect all bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts." Test a minimum of 10% of all high strength bolts for proper tension.
- D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
 1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Ultrasonic Inspection: ASTM E 164.

END OF SECTION 051200

SECTION 052100 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. Joist accessories.

B. Related Sections:

1. Section 01 81 13 "Sustainable Design Requirements" for additional LEED requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. LEED Documentation Submittals:

1. Comply with submittal requirements of Division 01 Section "Sustainable Design Requirements" including, but not limited to:
 - a. LEED Criteria Worksheet.
 - b. Recycled Content Information.
 - c. Regional Materials Information.
 - d. Low Emitting Materials Information.
 - e. LEED Materials and Resources Calculator.

C. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer certificates.

C. Mill Certificates: For each type of bolt.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
 - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

2.2 PRIMERS

- A. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
- B. Primer: Provide shop primer that complies with Section 099123 "Interior Painting."

2.3 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. Furnish 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 (13 mm) of finished wall surface unless otherwise indicated.
- C. 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.
- D. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.4 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories.
- B. Apply one coat of shop primer to joists and joist accessories.

PART 3 - EXECUTION

3.1 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 instructions, 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. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel 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 carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- F. 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.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
- C. Visually inspect bolted connections.
- D. Prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.

B. Related Sections:

1. Section 01 81 13 "Sustainable Design Requirements" for additional LEED requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. LEED Documentation Submittals:

1. Comply with submittal requirements of Division 01 Section "LEED Sustainable Design Requirements" including, but not limited to:
 - a. LEED Criteria Worksheet.
 - b. Recycled Content Information.
 - c. Regional Materials Information.
 - d. LEED Materials and Resources Calculator

C. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Evaluation reports.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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."

2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Canam United States; Canam Group Inc.
 - 2. Epic Metals Corporation
 - 3. Marlyn Steel Decks, Inc.
 - 4. New Millennium Building Systems, LLC
 - 5. Nucor Corp.; Vulcraft Group
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
 - 1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating. Retain steel grade from options in "Galvanized and Shop-Primed Steel Sheet" Subparagraph below.
 - 2. Deck Profile: As indicated.
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: As indicated.

2.3 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners:
 - 1. Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners.
 - 2. Design and manufacture: Knurled shank with forged ballistic point. Manufacturing process shall ensure steel ductility and prevent development of hydrogen embrittlement.
 - 3. Fastener types: Provide the following or approved alternate:
 - a. Hilti X-HSN 24 (supports with top chord or flange thickness 1/8 in. to 3/8 in.)
 - b. Hilti X-ENP-19 L15 (supports with flange thickness 1/4 in. or greater)

C. Side-Lap Fasteners:

1. Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws
2. Design and Manufacture: Hex washer head undercut with reverse serrations; self-piercing or stitch point at center.
3. Fastener types: Provide the following or approved alternate:
 - a. Hilti S-SLC01 M HWH Sidelap Connector (20 and 22 gauge deck)
 - b. Hilti S-SLC02 M HWH Sidelap Connector (16 and 18 gauge deck)
4. Drive mechanical sidelap connectors completely through adjacent lapped roof deck sheets to achieve positive engagement of adjacent sheets with a minimum of three thread penetration.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- C. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- D. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- E. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- F. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
- G. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (305 mm) apart with at least one fastener at each corner.

- H. 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.
- I. Floor-Deck Closures: Fasten steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Mechanical Fasteners: Inspect fasteners and confirm placement complies with the required spacing and patterns indicated on drawings. Replace or supplement under-drive and over-driven fasteners with adjacent, properly installed fasteners.
- C. Prepare test and inspection reports.

3.3 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Soffit framing.

B. Related Sections:

1. Section 01 81 13 "Sustainable Design Requirements" for additional LEED requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Documentation Submittals:

1. Comply with submittal requirements of Division 01 Section "LEED Sustainable Design Requirements" including, but not limited to:
 - a. LEED Criteria Worksheet.
 - b. Recycled Content Information.
 - c. Regional Materials Information.
 - d. LEED Materials and Resources Calculator

C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

D. Delegated-Design Submittal: For cold-formed steel framing

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product certificates.

C. Product test reports.

- D. Evaluation Reports: For non-standard cold-formed steel framing from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. AllSteel & Gypsum Products, Inc.
 - 2. ClarkWestern Building Systems, Inc.
 - 3. Consolidated Fabricators Corp.; Building Products Division
 - 4. Dietrich Metal Framing, a Worthington Industries Company
 - 5. MarionWARE
 - 6. Steel Network, Inc. (The)

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
 - 1. Professional Engineer Requirements: 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.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated on Drawings.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F .
 4. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Wall Studs: AISI S211.
 2. Headers: AISI S212.
 3. Lateral Design: AISI S213.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance.
 2. Coating: G60 (Z180).
- B. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance.
 2. Coating: G60 (Z180).

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: As required by structural performance.
 2. Flange Width: As required by structural performance.
 3. Section Properties: As required by structural performance.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and matching minimum base-metal thickness of steel studs.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.

- E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
- F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.5 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: As required by structural performance.
 - 2. Flange Width: As required by structural performance.
 - 3. Section Properties: As required by structural performance.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A 780/A 780M, MIL-P-21035B, or SSPC-Paint 20.

- B. Cement Grout: Portland cement, ASTM C 150/C 150M, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C 1107/C 1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.2 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
- D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- E. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire

integrated supporting structure has been completed and permanent connections to framing are secured.

- F. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- G. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.3 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: As indicated on Shop Drawings.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 - 3. Connect vertical deflection clips to bypassing or infill studs and anchor to building structure.
 - 4. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.
 - 1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches (305 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.4 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

END OF SECTION 054000

SECTION 05 52 13 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum railings.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's product lines of mechanically connected railings.
2. Metal finishes.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For delegated-design professional engineer.

B. Welding certificates.

C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

1.4 QUALITY ASSURANCE

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

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

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.

2.3 ALUMINUM RAILINGS

- A. Aluminum, General: Provide 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 designated below for each aluminum form required.
- B. Extruded Bars and Tubing: ASTM B221, Alloy 6063-T5/T52.
- C. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
 - 1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
- D. Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.
- E. Plate and Sheet: ASTM B209, Alloy 6061-T6.
- F. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
- G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.4 FASTENERS

- A. Fastener Materials:
 - 1. Aluminum Railing Components: Type 304 stainless steel fasteners.

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

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
 - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
 - 2. Water-Resistant Product: At exterior locations and where indicated on Drawings, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- B. Form work true to line and level with accurate angles and surfaces.
- C. 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 Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay
- D. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- E. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- F. Form changes in direction as follows:
 - 1. As detailed.

- G. 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.
- H. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- J. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
 - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 - 2. Coordinate anchorage devices with supporting structure.
- K. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
 - 1. Provide socket covers designed and fabricated to resist being dislodged.
 - 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

2.7 ALUMINUM FINISHES

- A. 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 unacceptable. 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.
- B. Mill Finish: AA-M12, nonspecular as fabricated.
- C. Clear Anodic Finish: AAMA 611, AA-M12C22A31.
- D. Color Anodic Finish: AAMA 611.
 - 1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.

3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 6. 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.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. 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.

3.2 ANCHORING POSTS

- A. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members.
- B. Install removable railing sections, where indicated on Drawing, in slip-fit stainless steel sockets cast in concrete.

3.3 CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

END OF SECTION 05 52 13

SECTION 06 10 53 - MISCELLANEOUS ROUGH CARPENTRY

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. Rooftop equipment bases and support curbs.
2. Wood blocking and nailers.
3. Wood furring and grounds.
4. Plywood backing panels.

- B. Related Requirements:

1. Section 06 16 00 "Sheathing" for sheathing, subflooring, and underlayment.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

1.4 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. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Metal framing anchors.

1.6 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- ### A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- #### A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

- #### B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- #### A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Treatment shall not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all miscellaneous carpentry unless otherwise indicated.
 - 1. Framing for raised platforms.
 - 2. Concealed blocking.
 - 3. Roof framing and blocking.
 - 4. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
 - 5. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Screws for Fastening to Metal Framing: ASTM C1002, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

2.7 METAL FRAMING ANCHORS

- A. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
 1. Use for interior locations unless otherwise indicated.
- B. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
 1. Use for wood-preserved-treated lumber and where indicated.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 1. Use for exterior locations and where indicated.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Do not splice structural members between supports unless otherwise indicated.

- F. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- G. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
 - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- H. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- I. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- J. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- K. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- L. Use steel common nails unless otherwise indicated. 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 between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal-size furring horizontally at 24 inches o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

3.4 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53

SECTION 06 16 00 - SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Parapet sheathing.

B. Related Sections:

1. Section 07 54 23 "Thermoplastic-Polyolefin (TPO) Roofing" for roof sheathing underlayment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product.

1.3 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
1. Fire-retardant-treated plywood.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WALL SHEATHING

- A. Glass-Mat Gypsum Wall Sheathing: ASTM C1177/C1177M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.; "GlasRoc Sheathing."
 - b. Georgia-Pacific Gypsum LLC.; "DensGlass Sheathing."

- c. National Gypsum Company; "exp Sheathing."
 - d. USG Corporation; "USG Securock Brand, Glass-Mat Sheathing."
- 2. Type and Thickness: Type X, 5/8 inch thick.
- B. Cementitious Backer Unit Wall Sheathing: ASTM C1325, Type A.
 - 1. Thickness: As indicated.

2.3 PARAPET SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Georgia-Pacific Gypsum LLC.; "DensDeck Roof Board."
 - b. National Gypsum Company; "DEXcell Glass Mat Roof Board."
 - c. USG Corporation; "USG Securock Brand, Ultralight Glass-Mat Roof Board."
 - 2. Type and Thickness: Regular, 1/2 inch thick.
 - 3. Size: 48 by 96 inches for vertical installation.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
 - 2. For wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.

2.5 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

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. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
 - 2. 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.
 - 3. ICC-ES evaluation report for fastener.
- D. Coordinate wall, parapet and roof 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.

3.2 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
 - 2. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
 - 3. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Seal sheathing joints according to sheathing manufacturer's written instructions.
 - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
 - 2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

3.3 CEMENTITIOUS BACKER UNIT INSTALLATION

- A. Install panels and treat joints in accordance with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

END OF SECTION 06 16 00

SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior standing and running trim.
2. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
3. Shop finishing of interior architectural woodwork.

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that exterior architectural woodwork can be supported and installed as indicated.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Anchors.
2. Adhesives.
3. Shop finishing materials.
4. Fire-Retardant Treatment: Include data and warranty information from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:

1. Include the following:
 - a. Dimensioned plans, elevations, and sections.
 - b. Attachment details.
2. Show large-scale details.
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.

- C. Samples: For each exposed product and for each shop-applied color and finish specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For architectural woodwork manufacturer.
- B. Product Certificates: For the following:
 - 1. Composite wood products.
 - 2. Adhesives.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.7 QUALITY ASSURANCE

- A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

1.8 FIELD CONDITIONS

- A. Environmental Limitations with Humidity Control: Do not deliver or install interior architectural woodwork 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 25 and 55 percent during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

2.2 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Architectural Woodwork Standards Grade: Custom.
- B. Hardwood Lumber:
 - 1. Species: White oak.
 - 2. Cut: Plain sliced/plain sawn.
 - 3. Wood Moisture Content: 5 to 10 percent.

4. Provide split species on trim that faces areas with different wood species, matching each face of woodwork to species and cut of finish wood surfaces in areas finished.
5. For trim items wider than available lumber, use veneered construction. Do not glue for width.
 - a. For veneered base, use hardwood lumber core, glued for width.
6. For base wider than available lumber, glue for width. Do not use veneered construction.
7. For rails thicker than available lumber, use veneered construction. Do not glue for thickness.

2.3 HARDWOOD SHEET MATERIALS

- A. Composite Wood Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
 1. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.4 FIRE-RETARDANT-TREATED WOOD MATERIALS

- A. Fire-Retardant-Treated Wood Materials: Where fire-retardant-treated materials are indicated, use materials complying with requirements that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products in accordance with test method indicated by a qualified testing agency.
 1. Use treated materials that comply with requirements of the Architectural Woodwork Standards. Do not use materials that are warped, discolored, or otherwise defective.
 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested in accordance with ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 2. For items indicated to receive a stained, transparent, or natural finish, use organic resin chemical formulation.
 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 4. Mill lumber before treatment, and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying

sticks or other causes, marring, and other defects affecting appearance of treated
woodwork.

2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Nailers: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
 - 1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
 - 2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.

2.6 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.
 - 1. Ease edges to radius indicated for the following:
 - a. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
- C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
 - 1. Disassemble components only as necessary for shipment and installation.
 - 2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
 - 3. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.
 - a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
 - b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.

2.7 SHOP PRIMING

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

2.8 SHOP FINISHING

- A. Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
- B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.
- C. Transparent Finish:
 1. Architectural Woodwork Standards Grade: Custom.
 2. See Drawings for finish system.
 3. Staining: Match Architect's sample.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.
- B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.2 INSTALLATION

- A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.
- B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.
- C. Install interior architectural woodwork level, plumb, true in line, and without distortion.
 1. Shim as required with concealed shims.
 2. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

- D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Fire-Retardant-Treated Wood: Install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- F. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.
 - 1. Secure with countersunk, concealed fasteners and blind nailing.
 - 2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with interior architectural woodwork.
 - 3. For shop-finished items, use filler matching finish of items being installed.
- G. Standing and Running Trim:
 - 1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
 - 2. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary.
 - 3. Scarf running joints and stagger in adjacent and related members.
 - 4. Fill gaps, if any, between top of base and wall with plastic wood filler; sand smooth; and finish same as wood base if finished.
 - 5. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
 - 1. Inspection entity is to prepare and submit report of inspection.

END OF SECTION 06 40 23

SECTION 06 41 16 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
2. Section 12 36 23.13 "Plastic-Laminate-Clad Countertops."

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Drawings to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
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 plastic-laminate architectural cabinets.
 5. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For the following:
1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
 - a. Provide one sample applied to core material with specified edge material applied to one edge.
 2. Thermoset Decorative Panels: 8 by 10 inches, for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
 3. Corner Pieces:
 - a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
 4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Certificates: For each type of product.
1. Composite wood and agrifiber products.
 2. Thermoset decorative panels.
 3. High-pressure decorative laminate.
 4. Glass.
 5. Adhesives.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.7 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
 - 1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Manufacturer of products Licensed participant in AWI's Quality Certification Program.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install cabinets 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 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets 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 cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. Provide labels and certificates from AWI certification program indicating that woodwork and installation complies with requirements of grades specified.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush overlay.
 - 1. Reveal Dimension: As indicated.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade VGS.
 - 4. Edges: Grade HGS.
 - 5. Pattern Direction: As indicated.
- G. Materials for Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 3.0 mm thick, matching laminate in color, pattern, and finish.
 - b. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
 - c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber.
 - 3. Drawer Bottoms: Hardwood plywood.
- H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.
- I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

- J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued dovetail joints.
- K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As indicated on the drawings.

2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
 - 1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
 - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
 - 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
 - 2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
 - 3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
 - 4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying

sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.

- C. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E84.
 - 1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
 - 2. For panels 13/16 to 1-1/4 inches thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi; modulus of elasticity, 250,000 psi; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf, respectively.
- D. Fire-Retardant Fiberboard: MDF panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E84.

2.4 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
 - 1. Semiconcealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
 - 2. Semiconcealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.
- C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening.
- D. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.
- E. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.
- F. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.
- G. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04102; with shelf brackets, B04112.
- H. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- I. Drawer Slides: ANSI/BHMA A156.9.
 - 1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.
 - a. Type: Full extension.

- b. Material: Epoxy-coated steel with polymer rollers.
- J. Door Locks: ANSI/BHMA A156.11, E07121.
- K. Drawer Locks: ANSI/BHMA A156.11, E07041.
- L. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- M. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
 - 1. Color: Black.
- N. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.
 - 1. Dark, Oxidized, Satin Bronze, Oil Rubbed: ANSI/BHMA 613 for bronze base; ANSI/BHMA 640 for steel base; match Architect's sample.
 - 2. Bright Brass, Clear Coated: ANSI/BHMA 605 for brass base; ANSI/BHMA 632 for steel base.
 - 3. Bright Brass, Vacuum Coated: ANSI/BHMA 723 for brass base; ANSI/BHMA 729 for zinc-coated-steel base.
 - 4. Satin Brass, Blackened, Bright Relieved, Clear Coated: ANSI/BHMA 610 for brass base; ANSI/BHMA 636 for steel base.
 - 5. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.
 - 6. Bright Chromium Plated: ANSI/BHMA 625 for brass or bronze base; ANSI/BHMA 651 for steel base.
 - 7. Satin Stainless Steel: ANSI/BHMA 630.
- O. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
- B. 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.

2.6 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly 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. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 2. Trial fit assemblies at manufacturer's 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 before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, 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.
- D. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual."
1. For glass in frames, secure glass with removable stops.
 2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.
 - 1. Inspection entity shall prepare and submit report of inspection.

3.4 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 06 41 16

SECTION 07 13 26 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modified bituminous sheet waterproofing.
2. Molded-sheet drainage panels.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials, and protection course from single source from single manufacturer.
- B. Modified Bituminous Sheet Waterproofing: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated on one side to a 4-mil-thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle Coating & Waterproofing Inc.; "CCW MiraDRI 860/861."
 - b. GCP Applied Technologies Inc.; "Bituthene."
 - c. Henry Company; "Blueskin WP 200."
 - d. W.R. Meadows, Inc.; "Mel-Rol."
 - 2. Physical Properties:
 - a. Tensile Strength, Membrane: 250 psi minimum; ASTM D412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D1970/D1970M.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C836/C836M.
 - e. Puncture Resistance: 40 lbf minimum; ASTM E154/E154M.
 - f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D570.
 - g. Water Vapor Permeance: 0.05 perm maximum; ASTM E96/E96M, Water Method.
 - h. Hydrostatic-Head Resistance: 200 feet minimum; ASTM D5385.
 - 3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.2 AUXILIARY MATERIALS

- A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
 - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid solvent-borne primer recommended for substrate by sheet-waterproofing material manufacturer.
- C. Surface Conditioner: Liquid surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.

- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch, predrilled at 9-inch centers.
- G. Protection Course, Asphaltic: ASTM D6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners and as follows:
 - 1. Thickness: Nominal 1/8 inch for vertical applications; 1/4 inch elsewhere.
 - 2. Adhesive: Rubber-based solvent type recommended by waterproofing manufacturer for protection course type.

2.3 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft..
 - 1. Basis of Design: Carlisle Coatings and Waterproofing Incorporated, "MiraDRAIN 6000/6200 Aggregate-Free Drainage System".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

3.2 INSTALLATION OF MODIFIED BITUMINOUS SHEET-WATERPROOFING

- A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch-minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
 - 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.
- D. Horizontal Application: Apply sheets from low to high points of decks to ensure that laps shed water.
- E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- F. Seal edges of sheet-waterproofing terminations with mastic.
- G. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.
- H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.
- I. Immediately install protection course with butted joints over waterproofing membrane.
 - 1. Molded-sheet drainage panels may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.3 INSTALLATION OF MOLDED-SHEET DRAINAGE-PANELS

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.4 PROTECTION, REPAIR, AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 13 26

SECTION 07 14 16 - COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold-applied rubberized asphalt waterproofing.
2. See Section 07 13 26 "Self-Adhering Sheet Waterproofing" for Molded-Sheet Drainage Panels.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings:

1. Show locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.6 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COLD-APPLIED RUBBERIZED ASPHALT WATERPROOFING

- A. Single-Component, Rubberized Asphalt Waterproofing: Single-component, silyl-terminated polyether complying with ASTM C836/C836M.
 - 1. Basis of Design: Carlisle Coatings and Waterproofing Incorporated.
 - a. Spray-Grade: "Barricoat-S" pourable consistency, water-based, polymer-modified asphalt.
 - b. Roller-Grade: "Barricoat-R" paste consistency, water-based, polymer-modified asphalt.
 - 2. Elongation at Break: 360 percent minimum; ASTM D412.
 - 3. Water Vapor Permeance: 0.03 perm (1.72 ng/Pa x s x sq. m), maximum, ASTM E96/E96M.
 - 4. Hydrostatic-Head Resistance: 100 psi average; ASTM D5385/D5385M.

2.2 AUXILIARY MATERIALS

- A. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated.
- B. Sheet Flashing: 50-mil-minimum, nonstaining, uncured sheet neoprene.
 - 1. Adhesive: Manufacturer's recommended contact adhesive.
- C. Membrane-Reinforcing Fabric: Manufacturer's recommended fiberglass mesh or polyester fabric.
- D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.
- E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; and as recommended by manufacturer for substrate and joint conditions.
 - 1. Backer Rod: Closed-cell polyethylene foam.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

- D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
- E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.
- F. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.
- G. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.
- H. Prepare, treat, rout, and fill joints and cracks in substrate in accordance with waterproofing manufacturer's written instructions and to recommendations in ASTM C1471/C1471M. Before coating surfaces, remove dust and dirt from joints and cracks in accordance with ASTM D4258.
- I. Install sheet flashing and bond to deck and wall substrates where required in accordance with waterproofing manufacturer's written instructions.

3.2 INSTALLATION OF WATERPROOFING

- A. Apply waterproofing in accordance with manufacturer's written instructions and to recommendations in ASTM C1471/C1471M.
- B. Unreinforced Waterproofing Applications.
 - 1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils.
- C. Reinforced Waterproofing Applications.
 - 1. Apply first coat of waterproofing, embed membrane-reinforcing fabric, and apply second coat of waterproofing to completely saturate reinforcing fabric and to obtain a seamless reinforced membrane free of entrapped gases and pinholes, with an average dry film total thickness of 70 mils.
- D. Install protection course with butted joints over waterproofing before starting subsequent construction operations.
 - 1. For horizontal applications, install protection course loose laid over fully cured membrane.
 - 2. For vertical applications, set protection course in nominally cured membrane, which will act as an adhesive. If membrane cures before application of protection course, use adhesive.
 - 3. Molded-sheet drainage panels may be used in place of a separate protection course for vertical applications when approved in writing by waterproofing manufacturer.

3.3 PROTECTION

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 07 14 16

SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Mineral-wool blanket insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Mineral-wool blanket insulation.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product test reports.

C. Research reports.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

A. Extruded Polystyrene Board Insulation, Type VII: ASTM C578, Type VII, 60-psi minimum compressive strength.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"

- a. DiversiFoam Products.

- b. Dow Chemical Company (The).
 - c. Owens Corning.
- 2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
- 3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
- 4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

- A. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Dow Chemical Company (The).
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Rmax, Inc.
 - 2. Thickness: 3-inch thick with a minimum R-value of not less than 18.
 - 3. Edge Treatment: Square edge.
 - 4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - 5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.
 - 6. Factory Score: Factory score board insulation for use in field cutting and fitting between Z-shaped furring members. Scoring shall occur on both face surfaces of board insulation

2.3 GLASS-FIBER BLANKET INSULATION

- A. Glass-Fiber Blanket Insulation, Kraft Faced: ASTM C665, Type II (nonreflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Knauf Insulation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.
 - 2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.4 MINERAL-WOOL BLANKET INSULATION

- A. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Fibrex Insulations Inc.
 - b. Isolatek International.
 - c. Roxul, Inc.
 - d. Thermafiber
 - 2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
 - 3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
 - 4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.5 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
 - 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
- B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.
- C. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 - 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.3 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.
 - 1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.
 - 3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 04 20 00 "Unit Masonry."

3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward as indicated on Drawings.
 - b. Interior Walls: Set units with facing placed as indicated on Drawings.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..
 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

END OF SECTION 07 21 00

SECTION 07 27 13 - MODIFIED BITUMINOUS SHEET AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes self-adhering, vapor-retarding, modified bituminous sheet air barriers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of modified bituminous sheet air barrier.
- B. Product test reports.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to set quality standards for materials and execution.
 - 1. Build integrated mockups of exterior wall assembly as indicated on Drawings, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
 - a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
 - b. Include junction with roofing membrane.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., when tested according to ASTM E2357.

2.2 SELF-ADHERING SHEET AIR BARRIER

- A. Modified Bituminous Sheet: 40-mil-thick, self-adhering sheet consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick, cross-laminated polyethylene film with release liner on adhesive side and formulated for application with primer that complies with VOC limits.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. Henry Company
 - c. Meadows, W. R., Inc.
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E2178.
 - b. Tensile Strength: Minimum 250 psi; ASTM D412, Die C.
 - c. Ultimate Elongation: Minimum 200 percent; ASTM D412, Die C.
 - d. Puncture Resistance: Minimum 40 lbf; ASTM E154/E154M.
 - e. Water Absorption: Maximum 0.15 percent weight gain after 48-hour immersion at 70 deg F; ASTM D570.
 - f. Vapor Permeance: Maximum 0.1 perm); ASTM E96/E96M, Desiccant Method.
 - g. Adhesion to Substrate: Minimum 16 lbf/sq. in. when tested according to ASTM D4541 as modified by ABAA.
 - h. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
 - i. UV Resistance: Can be exposed to sunlight for 60 days according to manufacturer's written instructions.

2.3 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Primer: Liquid waterborne primer recommended for substrate by air-barrier material manufacturer.
- C. Counterflashing Strip: Modified bituminous 40-mil- thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil- thick, cross-laminated polyethylene film with release liner backing.
- D. Modified Bituminous Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick, cross-laminated polyethylene film with release liner backing.
- E. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.
- F. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft. density; flame-spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
- G. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
- H. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Division 07 Section "Joint Sealants."

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

- D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- E. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.
- F. Bridge isolation joints, expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.2 INSTALLATION

- A. Install materials according to air-barrier manufacturer's written instructions and details and according to recommendations in ASTM D6135 to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous air-barrier sheet produced for low-temperature application. Do not install low-temperature sheet if ambient or substrate temperature is higher than 60 deg F.
 - 2. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere air-barrier sheets over area to receive air barrier. Accurately align sheets and maintain uniform 2-1/2-inch-minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure airtight installation.
 - 1. Apply sheets in a shingled manner to shed water.
 - 2. Roll sheets firmly to enhance adhesion to substrate.
- D. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
- E. Connect and seal exterior wall air-barrier sheet continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
- G. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.
- H. Do not cover air barrier until it has been tested and inspected by testing agency.

- I. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Continuous structural support of air-barrier system has been provided.
 3. Site conditions for application temperature and dryness of substrates have been maintained.
 4. Maximum exposure time of materials to UV deterioration has not been exceeded.
 5. Surfaces have been primed.
 6. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
 7. Termination mastic has been applied on cut edges.
 8. Air barrier has been firmly adhered to substrate.
 9. Compatible materials have been used.
 10. Transitions at changes in direction and structural support at gaps have been provided.
 11. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 12. All penetrations have been sealed.
- C. Tests: As determined by testing agency from among the following tests:
 1. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783.
 2. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. of installed air barrier or part thereof.
- D. Air barriers will be considered defective if they do not pass tests and inspections.
 1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- F. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

END OF SECTION 07 27 13

SECTION 07 46 46 - FIBER-CEMENT SIDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fiber-cement siding and soffit.

1.2 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples for Initial Selection: For fiber-cement siding including related accessories.
- C. Samples for Verification: For each type, color, texture, and pattern required.
 - 1. 12-inch-long-by-actual-width sample of siding and soffit.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement siding.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full lengths of fiber-cement siding including related accessories, in a quantity equal to 2 percent of amount installed.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures including cracking and deforming.
 - b. Deterioration of materials beyond normal weathering.
2. Warranty Period: Manufacturer's standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

1. Provide: Nichiha USA Inc. No alternates or other manufacturers or products will be considered.
 - a. Illumination Series.
 - b. Vintagewood.
 - c. Kurastone Series Stacked Stone.

2.2 FIBER-CEMENT SIDING

- A. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
- B. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- C. Nominal Thickness: See Drawings.
- D. Horizontal Pattern: See Drawing.
- E. Panel Texture: See Drawings.
- F. Factory Priming: Manufacturer's standard acrylic primer.

2.3 ACCESSORIES

- A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
 - 1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.
- B. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated:
 - 1. Corner posts.
 - 2. Door and window casings.
 - 3. Fasciae.
 - 4. Moldings and trim.
- C. Flashing: Provide flashing complying with Section 07 62 00 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
- D. Fasteners:
 - 1. For fastening to wood, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1 inch into substrate.
 - 2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch, or three screw-threads, into substrate.
 - 3. For fastening fiber cement, use hot-dip galvanized fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement siding and related accessories.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
 - 1. Do not install damaged components.
 - 2. Install fasteners no more than 24 inches o.c.
- B. Install joint sealants as specified in Section 07 92 00 "Joint Sealants" and to produce a weathertight installation.

3.4 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 46 46

SECTION 07 54 23 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adhered thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Roof insulation.
5. Insulation accessories and cover board.
6. Walkways.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with adjoining air barrier.

C. Samples: For the following products:

1. Roof membrane and flashings, of color required.
2. Walkway pads or rolls, of color required.

D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of compliance with performance requirements.
2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

B. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

C. Research reports.

D. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

E. Field quality-control reports.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
 - a. Installers shall be certified by the FM Global roofing installer program.

B. Source Limitations: Obtain components including roof insulation for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer.

C. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

- D. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- E. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.
 - 8. Review temporary protection requirements for roofing system during and after installation.
 - 9. Review roof observation and repair procedures after roofing installation.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

- B. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
 - 1. Fire/Windstorm Classification: as indicated.
 - 2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34, as indicated.
 - 3. Wind Uplift Load Capacity: as indicated.
- E. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

- A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, TPO sheet.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Firestone Building Products Company
 - b. Carlisle SynTec Incorporated
 - c. GAF Materials Corporation
 - d. Johns Manville
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: White.

2.3 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Bonding Adhesive: Manufacturer's standard.

- E. Slip Sheet: Manufacturer's standard, of thickness required for application.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD

- A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Thickness: Type X, 5/8 inch thick.
 - 2. Surface Finish: Unprimed.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. Size: 48 by 96 inches.
 - 2. Thickness:
 - a. Base Layer: 3".
 - b. Upper Layer: 3".
- B. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4 inch.
 - 3. Slope:
 - a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.6 INSULATION ACCESSORIES AND COVER BOARD

- A. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

- B. Glass-Mat Gypsum Cover Board: ASTM C1177/C1177M, water-resistant gypsum board.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Georgia-Pacific Corporation.
 - b. United States Gypsum Co.
 - 2. Thickness: 5/8 inch.
 - 3. Surface Finish: Factory primed.
- C. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
 - 1. Size: Approximately 36 by 60 inches.
 - 2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.2 PREPARATION

- A. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
 - 1. Submit test result within 24 hours after performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition.
- D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 07 27 13 "Modified Bituminous Sheet Air Barriers."

3.4 INSTALLATION OF SUBSTRATE BOARD

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
 - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
 - 2. Tightly butt substrate boards together.
 - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29.
 - 5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.
 - 6. Loosely lay substrate board over roof deck.

3.5 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows.
 - a. Locate end joints over crests of decking.
 - b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

- d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Loosely lay base layer of insulation units over substrate.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - f. Fill gaps exceeding 1/4 inch with insulation.
 - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - h. Loosely lay each layer of insulation units over substrate.
 - i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
- 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Loosely lay cover board over substrate.
5. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
 - b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

- B. Install slip sheet over cover board and beneath roof membrane.

3.7 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer, and install fabric-backed roof membrane. Do not apply to splice area of roof membrane.
- G. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.
- H. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- I. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- J. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, 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 roof membrane and sheet flashings.
 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- K. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.8 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to 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 to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 INSTALLATION OF WALKWAYS

- A. Flexible Walkways:
 1. Install flexible walkways at the following locations:
 - a. Locations indicated on Drawings.
 - b. As required by roof membrane manufacturer's warranty requirements.
 2. Provide 6-inch clearance between adjoining pads.
 3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Adhesion Testing: Test roof membrane for adhesion according to industry standard testing methods.
 - a. Provide one test for each 500 square feet.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

- a. Notify Owner and Architect 48 hours in advance of date and time of inspection.
- D. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with specified requirements.
- E. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 07 54 23

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formed low-slope roof sheet metal fabrications.
 - 2. Formed wall sheet metal fabrications.
 - 3. Formed equipment support flashing.

1.2 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each of the following
 - 1. Underlayment materials.
 - 2. Elastomeric sealant.
 - 3. Butyl sealant.
 - 4. Epoxy seam sealer.
- B. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details for forming, including profiles, shapes, seams, and dimensions.
 - 3. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 - 4. Include details of connections to adjoining work.
- C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.
- D. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
- E. Samples for Verification: For each type of exposed finish.
 - 1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.

2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved.
- C. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.
- E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
 1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
 2. Protect stored sheet metal flashing and trim from contact with water.

- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.8 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows 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 Delta E units when tested in accordance with ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
 - 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 PERFORMANCE REQUIREMENTS

- A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

2.2 SHEET METALS

- A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide prepainted by coil-coating process to comply with ASTM A755/A755M.
 - 1. Surface: Smooth, flat.
 - 2. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (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.

3. Color: Match Architect's sample.
4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 2. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 3. Fasteners for Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
 4. Fasteners for Zinc Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

- D. Elastomeric Sealant: ASTM C920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.5 FABRICATION, GENERAL

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
 - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
 - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
 - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
 - 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
 - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
 - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Seams:
 - 1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- G. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.
 - 1. Install in shingle fashion to shed water.
 - 2. Lap joints not less than 2 inches.
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
 - 1. Lap horizontal joints not less than 4 inches.
 - 2. Lap end joints not less than 12 inches.
- C. Self-Adhering, High-Temperature Sheet Underlayment:
 - 1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
 - 2. Prime substrate if recommended by underlayment manufacturer.
 - 3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
 - 4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
 - 5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
 - 6. Roll laps and edges with roller.
 - 7. Cover underlayment within 14 days.
- D. Install slip sheet, wrinkle free, directly on substrate before installing sheet metal flashing and trim.
 - 1. Install in shingle fashion to shed water.
 - 2. Lapp joints not less than 4 inches.

3.3 INSTALLATION, GENERAL

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.
 - 1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of welds sealant.
 - 3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
 - 5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
 - 6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 - 7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
 - 8. Do not field cut sheet metal flashing and trim by torch.
 - 9. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
 - 1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
 - 2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
 - 3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
 - 1. Use sealant-filled joints unless otherwise indicated.
 - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
 - b. Form joints to completely conceal sealant.

- c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
 - d. Adjust setting proportionately for installation at higher ambient temperatures.
 - 1) Do not install sealant-type joints at temperatures below 40 deg F.
 - 2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
- G. Rivets: Rivet joints in where necessary for strength.

3.4 INSTALLATION OF MISCELLANEOUS FLASHING

- A. Equipment Support Flashing:
- 1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
 - 2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
- 1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
 - 2. Pipe and install drain line to plumbing waste or drainage system.

3.5 INSTALLATION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

3.7 PROTECTION

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 07 62 00

SECTION 07 71 00 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - A. Copings.
 - B. Roof-edge drainage systems.
- B. Preinstallation Conference: Conduct conference at Project site.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roof specialties.
 - A. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
- C. Samples: For each type of roof specialty and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For tests performed by a qualified testing agency.
- B. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.

1.6 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 07 54 23 "Thermoplastic-Polyolefin (TPO) Roofing."

- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - A. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - B. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. FM Approvals' Listing: Manufacture and install copings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, as indicated. Identify materials with FM Approvals' markings.
 - A. Design Pressure: As indicated on Drawings.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent 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 calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - A. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COPINGS

- A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.
 - A. Basis of Design:
 - a. Hickman Edge Systems, "PermaSnap Plus".
 - B. Metallic-Coated Steel Sheet Coping Caps: Zinc-coated (galvanized) steel, nominal thickness as required to meet performance requirements.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Two-coat fluoropolymer.
 - c. Color: As selected by Architect from manufacturer's full range.
 - C. Corners: Factory mitered and mechanically clinched and sealed watertight.
 - D. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.

- a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.
- b. Face-Leg Cleats: Concealed, continuous galvanized-steel sheet.

2.3 ROOF-EDGE DRAINAGE SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. OMG Edge Systems.
 - b. Architectural Products Co., Inc.
 - c. Fabral.
- B. 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.
 - A. Zinc-Coated Steel: Nominal 0.028-inch thickness.
 - B. Gutter Profile: As indicated according to SMACNA's "Architectural Sheet Metal Manual."
 - C. Corners: Factory mitered and mechanically clinched and sealed watertight.
 - D. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
 - E. Gutter Accessories: Continuous screened leaf guard with sheet metal frame.
- C. Downspouts: Open-face rectangular complete with machine-crimped smooth-curve elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
 - A. Zinc-Coated Steel: Nominal 0.028-inch thickness.
- D. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof.
 - A. Zinc-Coated Steel: Nominal 0.028-inch thickness.
- E. Conductor Heads: Manufactured conductor heads, 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.
 - A. Zinc-Coated Steel: Nominal 0.028-inch thickness.
- F. Zinc-Coated Steel Finish: Two-coat fluoropolymer.
 - A. Color: As selected by Architect from manufacturer's full range.

2.4 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
- B. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
- D. Copper Sheet: ASTM B370, cold-rolled copper sheet, H00 or H01 temper.

2.5 UNDERLAYMENT MATERIALS

- A. 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.
 - A. Thermal Stability: ASTM D1970/D1970M; stable after testing at 240 deg F.
 - B. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F.
- B. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- C. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. minimum.

2.6 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 - A. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 - B. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.7 FINISHES

- A. Coil-Coated Galvanized-Steel Sheet Finishes:

- A. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with ASTM A755/A755M and coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
 - A. Apply continuously under copings.
 - B. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.
- B. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
- C. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.2 INSTALLATION, GENERAL

- A. Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - A. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - B. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - C. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - D. Torch cutting of roof specialties is not permitted.
 - E. Do not use graphite pencils to mark metal surfaces.
- 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.

- A. Coat concealed side of uncoated aluminum and stainless steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
- B. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
 - A. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
 - B. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.3 INSTALLATION OF COPING

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
 - A. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

3.4 INSTALLATION OF ROOF-EDGE DRAINAGE-SYSTEM

- A. 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 12 inches apart. Attach ends with rivets and solder to make watertight. Slope to downspouts.
 - A. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion-joint caps.
 - B. Install continuous leaf guards on gutters with noncorrosive fasteners, hinged to swing open 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.
 - A. Connect downspouts to underground drainage system indicated.
- D. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
- E. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below scupper discharge.

3.5 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed.

END OF SECTION 07 71 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof hatches.

1.2 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.

1. Roof hatches shall be approved in accordance with Miami Dade County Test Protocols.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Notice of Acceptance Letter: Provide roof hatch manufacturer's notice of acceptance letter certifying compliance with Miami Dade County testing standards.

- 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.6 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 noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.
 - 1. Factory Prime Coating: Where field painting is indicated, apply pretreatment and factory-applied, alkyd base red oxide primer coat, with a minimum dry film thickness of 0.2 mil.
- B. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- C. Steel Tube: ASTM A 500, round tube.

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.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Underlayment:
 - 1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
 - 2. Polyethylene Sheet: 6-mil-thick polyethylene sheet complying with ASTM D 4397.
 - 3. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.
- F. 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 nonremovable 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.

- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. 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.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated single-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis Hatchways, Inc.
 - b. Bilco Company
 - c. Dur-Red Products, Inc.
 - d. J. L. Industries, Inc.
 - e. Milcor, Inc.
 - f. Nystrom Products Co.
- B. Type and Size: Single-leaf lid, 30 by 36 inches.
- C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.
- D. Hatch Material: Zinc-coated (galvanized) steel sheet, 0.075 (14 gauge) inch thick.
 - 1. Finish: Factory prime coating.
- E. Construction:
 - 1. Insulation: Glass-fiber board.
 - 2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 - 3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 - a. Steel Sheet Thickness: 0.0299inch (22 gauge) thick.
 - 4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 - 5. Fabricate curbs of same material and finish as metal hatch lid and at a minimum height of 12 inches unless otherwise indicated.
 - 6. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

- F. Hardware: Stainless-steel spring latch with turn handles, heavy-duty butt- or pintle-type hinge system, hold-open arms with a 1 inch diameter red vinyl grip handle and padlock hasps inside and outside.
 - 1. Provide two-point latch on lids larger than 84 inches.
- G. Ladders: Refer to Division 05 Section "Metal Fabrications" for metal ladders.
- H. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
 - 1. Height: 42 inches above finished roof deck.
 - 2. Posts and Rails: Galvanized-steel pipe of 1-1/4 inches in diameter, or galvanized-steel tube of 1-5/8 inches in diameter, or fiberglass reinforced polymer tube of 1-15/16 inches in diameter.
 - a. Fiberglass reinforced polymer tubing shall be round pultruded reinforced fire retardant yellow fiberglass treated with a UV inhibitor.
 - 3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
 - 4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
 - 5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
 - 6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
 - 7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
 - 8. Fabricate joints exposed to weather to be watertight.
 - 9. Fasteners: Manufacturer's standard, finished to match railing system.
 - 10. Finish: Manufacturer's standard baked enamel or powder coat.
 - a. Color: Yellow, unless otherwise indicated.
- I. 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: High strength steel tube.
 - 4. Post: Square tubing.
 - 5. Finish: Manufacturer's standard baked enamel or powder coat.
 - a. Color: Yellow, unless otherwise indicated.

2.4 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. Coat concealed side of roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
 - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. 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 safety railing system to roof-hatch curb.
 4. Attach ladder-assist post according to manufacturer's written instructions.
- D. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.
- E. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

- A. Touch up factory-primed surfaces with compatible primer ready for field painting according to Division 09 Section "Exterior Painting."
- B. Clean exposed surfaces according to manufacturer's written instructions.
- C. Clean off excess sealants.
- D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 72 00

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Preformed joint sealants.

B. Related Sections:

1.2 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. 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.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

D. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

1.5 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.

1.6 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: Two 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: Five years from date of Substantial Completion.
- 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: 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.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 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.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining 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. Colors of Exposed Joint Sealants: Match Architect's samples.

2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. For Horizontal and Vertical Applications:
 - a. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - 1) Dow Corning Corporation; 756 SMS.
 - 2) GE Advanced Materials - Silicones; SilPruf SCS9000.
 - 3) Tremco Incorporated; Spectrem 3.
- B. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Dow Corning; 786 Mildew Resistant Silicone Sealant.
 - b. GE Advanced Materials - Silicones; Sanitary SCS 1700.
 - c. Tremco, an RPM Co.; Tremsil 200 Sanitary.

2.3 URETHANE JOINT SEALANTS

- A. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
 - 1. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Pecora Corporation; Dynatrol II.
 - b. Polymeric Systems, Inc.; PSI-270.
 - c. Tremco Incorporated; Dymeric 240.
- B. Immersible Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T and I.
 - 1. For Horizontal Applications with Slopes not Exceeding 5% (Self Leveling):

- a. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - 1) BASF Building Systems; Sonolastic SL 2.
 - 2) Pecora Corporation; Urexpan NR-200.
 - 3) Tremco Incorporated; THC 900.
2. For Horizontal Applications with Slopes Exceeding 5%:
 - a. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - 1) BASF Building Systems; Sonolastic SL 2.
 - 2) Tremco Incorporated; THC 901.

2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 1. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. BASF Building Systems; Sonolac.
 - b. Pecora Corporation; AC-20+.
 - c. Tremco Incorporated; Tremflex 834.

2.5 PREFORMED JOINT SEALANTS

- A. Preformed Silicone Joint Sealants: Manufacturer's standard sealant consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
 1. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Dow Corning Corporation; 123 Silicone Seal.
 - b. GE Advanced Materials - Silicones; UltraSpan US1100.
 - c. Pecora Corporation; Sil-Span.
- B. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, 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 precompressed 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. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Dayton Superior Specialty Chemicals; Polytite Standard.
 - b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
 - c. Willseal USA, LLC; Willseal 600.

2.6 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; 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.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 1. Products: Subject to compliance with requirements, provide one of the following products or proposed substitution complying with Division 01 Section "Substitution Procedures:"
 - a. Type C: (Closed-cell material with a surface skin.)
 - 1) HBR Closed Cell Backer Rod; Nomaco, Inc.
 - 2) Sonneborn Closed-Cell Backer-Rod; BASF.
 - b. Type B: (Bicellular material with a surface skin.)
 - 1) SOFROD; Nomaco, Inc.
 - 2) Sonneborn Sonolastic Soft Backer-Rod; BASF.
- C. 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. Provide self-adhesive tape where applicable.

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: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

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.
 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.
- 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 bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. 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.
- F. Tooling of Nonsag 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.
- G. 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.
- H. 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.

3.4 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.

3.5 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.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces subject to water immersion.
 - 1. Joint Locations:
 - a. Joints between paving.
 - b. Other joints as indicated.
 - 2. Urethane Joint Sealant: Immersible, multicomponent, pourable, traffic grade.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone cladding.
 - d. Joints between metal panels.
 - e. Joints between different materials listed above.
 - f. Perimeter joints between materials listed above and frames of doors, windows and louvers.
 - g. Control and expansion joints in ceilings and other overhead surfaces.
 - h. Other joints as indicated.
 - 2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Exterior joints in vertical surfaces.
 - 1. Joint Locations:
 - a. Joints between different materials as directed by Architect.
 - b. Other joints as indicated.
 - 2. Urethane Joint Sealant: Multicomponent, nonsag,, Class 50.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical joints on exposed surfaces of walls and partitions.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.
 - e. Other joints as indicated.
 - 2. Joint Sealant: Latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Sealant Location:

- a. Joints between plumbing fixtures and adjoining walls, floors, counters, vanities, and at janitor closet mop receptor to wall transition
- b. Tile control and expansion joints where indicated.
- c. Other joints as indicated.

2. Joint Sealant: Mildew resistant, single component, nonsag, neutral curing, Silicone.

3. Joint Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Interior standard steel doors and frames.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.

8. Details of accessories.
 9. Details of moldings, removable stops, and glazing.
- D. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.
- E. Samples for Verification:
1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
 2. Fabrication: Prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- F. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
 3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.
- C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.
- D. Field quality control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.7 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
 - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide one of the following:
 - 1. Ceco Door Products
 - 2. Curries
 - 3. Steelcraft

2.2 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches.
- c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
- d. Edge Bevel: Provide manufacturer's standard beveled or square edges.
- e. Core: Manufacturer's standard.

2. Frames:

- a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
- b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.
- c. Construction: Full profile welded.

3. Exposed Finish: Prime.

2.3 HOLLOW-METAL PANELS

- A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.4 FRAME ANCHORS

A. Jamb Anchors:

- 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
- 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
- 3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

- 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.5 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- F. 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 hollow-metal frames of type indicated.
- G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- H. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.6 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
- B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
 1. Color and Gloss: As indicated by manufacturer's designations Match Architect's sample As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 2. Fire-Rated Openings: Install frames according to NFPA 80.
 3. Floor Anchors: Secure with postinstalled expansion anchors.

- a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 3. Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.
 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 31 13 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access doors and frames for walls and ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details materials, individual components and profiles, and finishes.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachments to other work.
2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.

D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

B. Flush Access Doors with Concealed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
2. Locations: Wall and ceiling.
3. Door Size: 24 by 24 inches, unless otherwise indicated.
4. Uncoated Steel Sheet for Door: Nominal 0.064 inch, 16 gage.
 - a. Finish: Factory prime.
5. Frame Material: Same material and thickness as door.
6. Hinges: Concealed continuous piano hinge.
7. Hardware: Provide each type of hardware in the following locations:
 - a. ATM Vestibule: Lock and latch.
 - b. All Other Interior Spaces: Latch, unless otherwise indicated.

C. Hardware:

1. Lock: Key operated cam lock with mortise cylinder to match cylinders used throughout the Project.
 - a. Finish: US26D - Satin Chromium plated, unless otherwise indicated.
 - b. Lock Preparation: Prepare door panel to accept a 1-1/8 inch diameter mortise cylinder.
2. Latch: Flush, screwdriver-operated cam latch of number required to hold door in flush, smooth plane when closed.
 - a. Provide not less than two latches for each access door panel. Locate latches at corners of door panel.

2.2 MATERIALS

- A. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- B. Frame Anchors: Same type as door face.
- C. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces 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, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 1. For concealed flanges with drywall bead, provide edge trim for gypsum board and gypsum base securely attached to perimeter of frames.
 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
 3. Provide mounting holes in frame for attachment of masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 1. For cylinder locks, furnish two keys per lock and key all locks alike.

2.4 FINISHES

- 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. 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.
- D. Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates 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. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 08 41 13 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront systems.
2. Aluminum-framed entrance door systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
4. Include point-to-point wiring diagrams showing the following:
 - a. Power requirements for each electrically operated door hardware.
 - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
- G. Delegated-Design Submittal: For aluminum-framed entrances and storefronts including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

- A. Preconstruction Laboratory Mockup Testing Submittals:
1. Testing Program: Developed specifically for Project.
 2. Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
 3. Record Drawings: As-built drawings of preconstruction laboratory mockups showing changes made during preconstruction laboratory mockup testing.
- B. Qualification Data:
1. For Installer and field testing agency.
 2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.
- C. Energy Performance Certificates: For aluminum-framed entrances and storefronts, accessories, and components, from manufacturer.
1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance and storefront.
- D. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.
- E. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C1401. Include periodic quality-control reports.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranties: For special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated and acceptable to Owner and Architect.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. 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.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- D. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of storefront systems that include structural glazing.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or 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. Noise or vibration created by wind and thermal and structural movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E 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, peeling, or chipping.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.
 1. Basis of Design – Framing: Kawneer, Trifab® VersaGlaze® 451/451T Framing System, 2" sightline, 4-1/2" frame depth, thermally broken at exterior, front set glazing.
 2. Basis of Design – Entrances: Kawneer, 190/350/500 Standard Entrances, 500 model, Wide Stile (5" sightline, 6-1/2" bottom rail), front set glazing.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
 1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding $1/175$ of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to $3/4$ inch, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to $1/360$ of clear span or $1/8$ inch, whichever is smaller.
 - a. Operable Units: Provide a minimum $1/16$ -inch clearance between framing members and operable units.
 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than $1/240$ of clear span plus $1/4$ inch for spans greater than 11 feet $8\text{-}1/4$ inches or $1/175$ times span, for spans of less than 11 feet $8\text{-}1/4$ inches.
- E. Structural: Test according to ASTM E330/E330M as follows:
1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Water Penetration under Static Pressure: Test according to ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
- G. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
 2. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement.
- I. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
1. Thermal Transmittance (U-factor):

- a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.41 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 - b. Entrance Doors: U-factor of not more than 0.68 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Solar Heat-Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.26 as determined according to NFRC 200.
 - b. Entrance Doors: SHGC of not more than 0.22 as determined according to NFRC 200.
3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of when tested according to ASTM E283.
 - b. Entrance Doors: Air leakage of not more than 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than 35 as determined according to AAMA 1503.
 - b. Entrance Doors: CRF of not less than 57 as determined according to AAMA 1503.
- J. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone for basic protection.
- K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
 2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - c. Interior Ambient-Air Temperature: 75 deg F.

2.3 STOREFRONT SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Exterior Framing Construction: Thermally broken.
 2. Interior Vestibule Framing Construction: Nonthermal.
 3. Glazing System: Retained mechanically with gaskets on four sides.

4. Glazing Plane: Front set.
 5. Finish: As selected from manufacturer's full range.
 6. Fabrication Method: Field-fabricated stick system.
 7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 8. Steel Reinforcement: As required by manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
 2. Door Design: As indicated.
 3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.
 4. Finish: Match adjacent storefront framing finish.

2.5 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: As specified in the Drawings.
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.
1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
 3. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion.
 - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

- C. Manual Flush Bolts: BHMA A156.16, Grade 1.
- D. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.
- E. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- F. Cylinders:
 - 1. As specified in Section 08 71 00 "Door Hardware."
 - 2. BHMA A156.5, Grade 1.
 - a. Keying: Master key system. Permanently inscribe each key with a visual key control number and include notation "DO NOT DUPLICATE".
- G. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.
- H. Operating Trim: BHMA A156.6.
- I. Removable Mullions: BHMA A156.3 extruded aluminum.
 - 1. When used with panic exit devices, provide keyed removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.
- J. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
- K. Concealed Overhead Holders and Stops: BHMA A156.8, Grade 1.
- L. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
- M. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: Made of ASTM D2000 molded neoprene or ASTM D2287 molded PVC.
 - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- N. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- O. Thresholds: BHMA A156.21 raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.
- P. Finger Guards: Manufacturer's standard collapsible neoprene or PVC gasket anchored to frame hinge-jamb at center-pivoted doors.

2.6 GLAZING

- A. Glazing: Comply with Section 08 80 00 "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: As recommended by manufacturer.

2.7 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.
- C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
- D. Structural Profiles: ASTM B308/B308M.
- E. Steel Reinforcement:
 - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, 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.

2.8 ACCESSORIES

- A. Automatic Door Operators: See Drawings.
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- F. Rigid PVC Filler.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. 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.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Storefront Framing: Fabricate components for assembly using shear-block system.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, or thicker.
 - 1. Color: As selected from manufacturer's full range.

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 the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 07 92 00 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 08 80 00 "Glazing."

3.4 INSTALLATION OF WEATHERSEAL SEALANT

- A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.
- B. Install weatherseal sealant to completely fill cavity, according to sealant manufacturer's written instructions, to produce weatherproof joints.

3.5 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

- A. Install entrance doors to produce smooth operation and tight fit at contact points.
 - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.6 ERECTION TOLERANCES

- A. Install aluminum-framed entrances and storefronts 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 more, 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.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
 - a. Perform a minimum of two tests in areas as directed by Architect.

- b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
 - 2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - a. Perform a minimum of two tests in areas as directed by Architect.
 - b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.
 - 3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
- C. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.8 MAINTENANCE SERVICE

- A. Entrance Door Hardware Maintenance:
 - 1. 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 entrance door hardware.
 - 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

3.9 ENTRANCE DOOR HARDWARE SETS

- A. See Drawings.

END OF SECTION 08 41 13

SECTION 08 42 29.23 - SLIDING AUTOMATIC ENTRANCES

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 interior, sliding, power-operated automatic entrances.

1.3 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. IBC: International Building Code.
- D. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- E. For automatic door terminology, refer to BHMA A156.10 for definitions of terms.

1.4 COORDINATION

- A. Coordinate sizes and locations of recesses in concrete floors for recessed sliding tracks that control automatic entrances. Concrete, reinforcement, and formwork requirements are specified elsewhere.
- B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing automatic entrances.
- C. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.
- D. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies and access-control system and remote monitoring systems.
- E. System Integration: Integrate sliding automatic entrances with other systems as required for a complete working installation.

1. Provide electrical interface control capability for activation of sliding automatic entrances by security access system on doors with electric locking.
2. Provide electrical interface to deactivate door operators on activation of fire alarm system.
3. Provide electrical interface to allow for remote monitoring of automatic entrance door panel status.

1.5 PREINSTALLATION MEETINGS

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

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For sliding automatic entrances.

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
2. 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.
4. Indicate locations of activation and safety devices.
5. Include hardware schedule and indicate hardware types, functions, quantities, and locations.

- C. Samples for Initial Selection: For units with factory-applied color and metal-clad finishes.

1. Include Samples of hardware and accessories involving color or finish selection.

- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

- E. Delegated-Design Submittal: For automatic entrances.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Certificates: For each type of automatic entrance. Include emergency-exit features of automatic entrances serving as a required means of egress.

- C. Product Test Reports: For each type of automatic entrance, for tests performed by a qualified testing agency.

- D. Field quality-control reports.
- E. Sample Warranties: For manufacturer's special warranties.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For automatic entrances, safety devices, and control systems to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer with Company Certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
 - 1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- C. Certified Inspector Qualifications: Certified by AAADM.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of automatic 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 operators, controls, and hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AUTOMATIC ENTRANCE ASSEMBLIES

- A. Source Limitations: Obtain sliding automatic entrances from single source from single manufacturer.
- 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. Power-Operated Door Standard: BHMA A156.10.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design automatic entrances.
- B. Structural Performance: Automatic entrances shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
- C. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone for basic protection.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- E. Operating Temperature Range: Automatic entrances shall operate within minus 20 to plus 122 deg F.
- F. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 1.25 cfm/sq. ft. of fixed entrance-system area when tested according to ASTM E283 at a minimum static-air-pressure difference of.
- G. Opening Force:
 - 1. Power-Operated Doors: Not more than 50 lbf required to manually set door in motion if power fails, and not more than 15 lbf required to open door to minimum required width.
 - 2. Breakaway Device for Power-Operated Doors: Not more than 50 lbf required for a breakaway door or panel to open.
- H. Entrapment-Prevention Force:
 - 1. Power-Operated Sliding Doors: Not more than 30 lbf required to prevent stopped door from closing.

2.3 SLIDING AUTOMATIC ENTRANCES

- A. General: Provide manufacturer's standard automatic entrances, including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, controls, and accessories required for a complete installation.
- B. All-Glass Automatic Entrance:
 - 1. Single-Sliding Units:
 - a. Stanley Door, Single-Sliding Dura-Glide Door, Model 3000, full break-out, with battery backup.
 - 2. Configuration: Single-sliding door with one sliding leaf sidelite.
 - a. Traffic Pattern: Two way.
 - b. Emergency Breakaway Capability: As indicated on Drawings.
 - c. Mounting: Between jambs.
 - 3. Operator Features:
 - a. Power opening and closing.
 - b. Drive System: Chain.
 - c. Adjustable opening and closing speeds.
 - d. Adjustable hold-open time between zero and 30 seconds.
 - e. Obstruction recycle.
 - f. On-off/hold-open switch to control electric power to operator, key operated.
 - g. Battery backup.
 - 4. Sliding-Door Carrier Assemblies and Overhead Roller Tracks: 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.
 - a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.
 - 5. Sliding-Door Threshold: Threshold members and bottom-guide-track system with stainless-steel, ball-bearing-center roller wheels.
 - a. Configuration: Saddle-type threshold across door opening and recessed guide-track system at sidelites.
 - 6. Controls: Activation and safety devices according to BHMA standards.
 - a. Activation Device: Motion sensor mounted on each side of door header to detect pedestrians in activating zone and to open door.
 - b. Safety Device: Two photoelectric beams mounted in sidelite jambs on each side of door to detect pedestrians in presence zone and to prevent door from closing.

- c. Sidelite Safety Device: Presence sensor, mounted above each sidelite on side of door opening through which doors travel, to detect obstructions and to prevent door from opening.
 - d. Opening-Width Control: Two-position switch that in the normal position allows sliding doors to travel to full opening width and in the alternate position reduces opening to a selected partial opening width.
- 7. Finish: Finish framing, door(s), and header as selected from manufacturer's full range.
 - 8. Metal Cladding and Finish: Clad framing, door(s), and header with metal sheet in finish as selected from manufacturer's full range.

2.4 ENTRANCE COMPONENTS

- A. Framing Members: Extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
 - 1. Nominal Size: As indicated on Drawings.
 - 2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.
- B. All-Glass Sliding Doors: Fabricated from 1/2-inch-thick tempered glass, with polished vertical edges and minimum 0.125-inch-thick, extruded-aluminum top and bottom rails.
 - 1. Rail Design: 3-1/2-inch nominal height.
- C. Sidelite(s): 1-3/4-inch-deep with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members matching door design.
 - 1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
- D. Headers: Fabricated from minimum 0.125-inch-thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
 - 1. Mounting: Concealed, with one side of header flush with framing.
 - 2. Capacity: Capable of supporting doors of up to 175 lb per leaf over spans of up to 14 feet without intermediate supports.
 - a. Provide sag rods for spans exceeding 14 feet.
- E. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- F. Signage: As required by cited BHMA standard.
 - 1. Application Process: Door manufacturer's standard process.
 - 2. Provide sign materials with instructions for field application after glazing is installed.

2.5 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Extrusions: ASTM B221.
 - 2. Sheet: ASTM B209.
- B. Steel Reinforcement: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
- C. Stainless-Steel Bars: ASTM A276/A276M or ASTM A666, type 304.
- D. Stainless-Steel Tubing: ASTM A554, Grade MT 304.
- E. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, type 304, stretcher-leveled standard of flatness, in entrance manufacturer's standard thickness.
- F. Glazing: As specified in on Drawings
- G. Sealants and Joint Fillers: As specified in Section 07 92 00 "Joint Sealants."
- H. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C1107/C1107M; of consistency suitable for application.
- I. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- J. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.6 DOOR OPERATORS AND CONTROLS

- A. General: Provide operators and controls, which include activation and safety devices, according to BHMA standards, for condition of exposure, and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.
- B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.
 - 1. Door Operator Performance: Door operators shall open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
 - 2. Electromechanical Operators: Concealed, self-contained, overhead units powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; complying with UL 325; and with manual operation with power off.

- C. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed by their plastic housings; adjustable to provide detection-field sizes and functions required by BHMA A156.10.
 - 1. Provide capability for switching between bi- and unidirectional detection.
 - 2. For one-way traffic, sensor on egress side shall not be active when doors are fully closed.
- D. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.7 HARDWARE

- A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.
- B. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Maximum force to open door shall be as stipulated in "Performance Requirements" Article. Interrupt powered operation of door operator while in breakaway mode.
 - 1. Include two adjustable detent devices mounted in each breakaway panel; one top mounted and one bottom mounted to control breakaway force.
 - a. Panel Closer: Factory-installed concealed hydraulic door closer.
 - b. Limit Arms: Limit swing to 90 degrees, spring loaded with adjustable friction damping.
- C. Deadlocks: Deadbolt operated by exterior cylinder and interior thumb turn, with minimum 1-inch-long throw bolt; BHMA A156.5, Grade 1.
 - 1. Cylinders: BHMA A156.5, Grade 1, six-pin mortise type.
 - a. Keying: Integrate into building master key system.
 - b. Keys: Two for each cylinder.
 - 2. Deadbolts: Steel, mortise type, BHMA A156.5, Grade 1.
 - 3. Lock/Unlock Indicator: Lock position indicators integrated with locking system. Stile is mounted on secure side of door. Visual display of lock position as follows: "OPEN" in black letters when unlocked, and "LOCKED" in red letters when locked.
 - 4. Armored Strike: Reinforced security strike plate.
- D. Uninterrupted Power Supply: UL 1778, fully integrated unit mounted within header.
 - 1. Power Interruption: Supply power to operator, controls, activation device, and safety systems of sliding automatic door for up to 1.5 hours of normal operation.
 - 2. Include low-battery shutdown feature to safely open or close door prior to complete battery discharge.
 - 3. Include audible battery replacement alarm to indicate that battery will no longer accept a charge and replacement is required.

- E. Dustproof Strikes for All-Glass Sliding Doors: Recessed, floor type, BHMA A156.16, Grade 1, to receive deadbolt.
- F. Weather Stripping: Replaceable components.
 - 1. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

2.8 ACCESSORIES

- A. Guide Rails: Anodized aluminum, fabricated from bars, minimum 30 inches high, and finished to match doors unless otherwise indicated; positioned and projecting from face of door jamb for distance as indicated, but not less than that required by BHMA A156.10 for type of door and direction of travel; with filler panel.
 - 1. Filler Panel: Expanded aluminum mesh.
 - a. Orient expanded aluminum mesh with long dimension of diamonds parallel to top rail.
 - b. Color: As selected by Architect from manufacturer's full range.
 - 2. Mounting: As indicated on Drawings.
 - 3. Aluminum Finish: As selected from manufacturer's full range.

2.9 FABRICATION

- A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
 - 1. Form aluminum shapes 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, fabricated from stainless steel.
 - a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, 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 automatic 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 sharp, 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. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
 7. Allow for thermal expansion of exterior units.
- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Metal Cladding: Factory-fabricated and -installed metal cladding, completely covering all visible surfaces as part of prefabricated entrance assembly before shipment to Project site.
1. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 2. Form profiles that are sharp, straight, and free of defects or deformations.
 3. Provide components with concealed fasteners and anchor and connection devices.
 4. Fabricate components with accurately fitted joints, with ends coped or mitered to produce hairline joints free of burrs and distortion.
 5. Fabricate exterior components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior. Allow for thermal expansion at exterior entrances.
- E. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.
- F. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."
- G. Hardware: Factory install hardware to 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.
1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors and breakaway sidelites.
- H. Controls:
1. General: Factory install activation and safety devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.
 2. Install photoelectric beams in vertical jambs of sidelites, with dimension above finished floor as follows:
 - a. Top Beam: 48 inches.

- b. Bottom Beam: 24 inches.

2.10 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- C. 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.

2.11 ALUMINUM FINISHES

- A. Aluminum Finish: As selected by Architect from full range of industry colors and color densities.
 - a. Color: As selected by Architect from full range of industry colors and color densities.

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 automatic entrances.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic entrance installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install automatic entrances according to manufacturer's written instructions and cited BHMA A156.10 for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.
 - 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.
 - 2. 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.
 - 3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.

- B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades 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.
 - 3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
 - 4. Level recesses for recessed thresholds using nonshrink grout.
- C. Door Operators: Connect door operators to electrical power distribution system.
- D. Access-Control Devices: Connect access-control devices to access-control system, as specified in Section 28 13 00 "Access Control Software and Database Management."
- E. Controls: Install and adjust activation and safety devices according to manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel. Connect control wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- F. Guide Rails: Install rails according to BHMA A156.10, including Appendix A, and manufacturer's written instructions unless otherwise indicated.
- G. Glazing: Install glazing as specified in Section 08 80 00 "Glazing."
- H. Sealants: Comply with requirements specified in Section 07 92 00 "Joint Sealants" to provide weathertight installation.
 - 1. Set thresholds, framing members and flashings in full sealant bed.
 - 2. Seal perimeter of framing members with sealant.
- I. Signage: Apply signage on both sides of each door and breakaway sidelite, as required by cited BHMA standard for direction of pedestrian travel.
- J. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 FIELD QUALITY CONTROL

- A. Certified Inspector: Engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Test and inspect each automatic entrance, using AAADM inspection forms, to determine compliance of installed systems with applicable BHMA standards.
- C. Automatic entrances will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust exterior doors for tight closure.
- B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- 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 up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 CLEANING

- 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.
 - 1. Comply with requirements in Section 08 80 00 "Glazing" for cleaning and maintaining glass.

3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include three months' full maintenance by skilled employees of automatic entrance Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 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, 7-day-per-week emergency callback service.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

END OF SECTION 08 42 29.23

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.
 - b. Sliding doors.
2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

B. Related Requirements:

1. Section 06 41 16 "Plastic-Laminate-Clad Architectural Cabinets" for cabinet door hardware provided with cabinets.
2. Section 08 11 13 "Hollow Metal Doors and Frames".
3. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" for entrance door hardware, cylinders.

1.2 COORDINATION

A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.

1. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings: For electrified door hardware.
 - 1. Include diagrams for power, signal, and control wiring.
 - 2. Include details of interface of electrified door hardware and building safety and security systems.
- C. Samples for Verification: For each type of exposed product, in each finish specified.
 - 1. Sample Size: Full-size units or minimum 2-by-4-inch Samples for sheet and 4-inch long Samples for other products.
 - 2. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- D. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other installation information.
 - f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - g. Mounting locations for door hardware.
 - h. List of related door devices specified in other Sections for each door and frame.
- E. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of electrified door hardware.

1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.
- C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 1. Warehousing Facilities: In Project's vicinity.
 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
 - a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design".
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
 - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 HINGES

A. Hinges: BHMA A156.1.

1. See Drawings for products.

2.4 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Trim:

1. Description: As indicated on Drawings.

C. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

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: Manufacturer's special strike box fabricated for aluminum framing.
4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

2.5 ELECTRIC STRIKES

A. Electric Strikes: BHMA A156.31; See Drawings, with faceplate to suit lock and frame.

2.6 EXIT LOCKS AND EXIT ALARMS

A. Exit Locks and Alarms: BHMA A156.29, Grade 1.

2.7 LOCK CYLINDERS

A. Standard Lock Cylinders: BHMA A156.5; permanent cores; face finished to match lockset.

1. Core Type: see Drawings.

- B. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- C. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.8 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.
 - 1. Master Key System: Change keys and a master key operate cylinders.
 - a. Provide three cylinder change keys and five master keys.
 - 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."

2.9 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.
- B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.
- C. Astragals: BHMA A156.22.

2.10 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.11 CONCEALED CLOSERS

- A. Concealed Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves. Comply with manufacturer's written instructions

for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.12 CLOSER HOLDER RELEASE DEVICES

- A. Closer Holder Release Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Automatic release is activated by .

2.13 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.

2.14 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.

2.15 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:
 - 1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
 - 2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
 - 3. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

2.16 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.17 SLIDING DOOR HARDWARE

- A. Sliding Door Hardware: BHMA A156.14; consisting of complete sets including rails, hangers, supports, bumpers, floor guides, and accessories indicated.

2.18 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
 3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.19 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. 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 doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's 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. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as directed by Owner.
 - 2. Furnish permanent cores to Owner for installation.
- F. Key Control System:
 - 1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
 - 2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel.

3. Key Control System Software: Set up multiple-index system based on final keying schedule.
- G. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated,. Verify location with Architect.
 1. Configuration: Provide one power supply for each door opening with electrified door hardware.
- H. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."
- I. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- J. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- K. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- L. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed 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.
 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
 3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door

hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

- A. See Drawings.

END OF SECTION 08 71 00

SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass for doors and storefront framing.
2. Glazing sealants and accessories.

1.2 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
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 temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

- D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For glass.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- C. Preconstruction adhesion and compatibility test report.
- D. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.10 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Five years from date of Substantial Completion.

- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: See Drawings.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
 1. Obtain tinted glass from single source from single manufacturer.
 2. Obtain reflective-coated glass from single source from single manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.
 - 1. Design Wind Pressures:
 - a. As indicated on Drawings.
 - 2. Design Snow Loads: As indicated on Drawings.
 - 3. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
 - 4. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
 - 5. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
 - 6. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Windborne-Debris Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for basic protection.
- E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- F. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
 - 2. For laminated-glass lites, properties are based on products of construction indicated.
 - 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
 - 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 - 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: "Glazing Manual."
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
 - 3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
 - 4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing 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.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
 - 1. Minimum Glass Thickness for Exterior Lites: 6 mm.
 - 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Ultraclear Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
- C. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.
- D. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

- E. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- F. Pyrolytic-Coated, Low-Maintenance Glass: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.
- G. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual."
- H. Reflective-Coated Vision Glass: ASTM C1376.
- I. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.
- J. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.
- K. Reflective-Coated Spandrel Glass: ASTM C1376, Kind CS.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
 - 1. Sealing System: Match existing. If retaining a specific spacer material, coordinate with manufacturers and products.
 - 2. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Colors of Exposed Glazing Sealants: Match existing. .

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for

application indicated, and with a proven record of compatibility with surfaces contacted in installation.

- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 GLASS SCHEDULE

- A. See Drawings.

END OF SECTION 08 80 00

SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For composite wall assemblies, limited to 1/360 of the wall height based on horizontal loading of 10 lbf/sq. ft..

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dietrich Metal Framing; a Worthington Industries Company.
 - b. MarinoWare, a division of Ware Industries.
 - c. The Steel Network, Inc.
 - 2. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
 - 3. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
 - 1. Steel Studs and Tracks:
 - a. Minimum Base-Steel Thickness: As indicated on Drawings.
 - b. Depth: As indicated on Drawings.
 - 2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.
 - a. Minimum Base-Steel Thickness: As indicated on Drawings.
 - b. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following:
 - 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 2-inch minimum vertical movement.
 - 2. Single Long-Leg Track System: ASTM C645 top track with 2-inch-deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 - 3. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
 - 4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of 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.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: As indicated on Drawings.
- F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch-wide flanges.
 1. Depth: As indicated on Drawings.
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C645.
 1. Minimum Base-Steel Thickness: As indicated on Drawings.
 2. Depth: As indicated on Drawings.
- H. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
 1. Configuration: hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
 1. Depth: As indicated on Drawings.
 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
 3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Hanger Attachments to Concrete:
 1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES as appropriate for the substrate.
 - a. Uses: Securing hangers to structure.
 - b. Type: Torque-controlled, expansion anchor.
 - c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 - d. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
 2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
 - 1. Depth: As indicated on Drawings.
- F. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
 - 2. Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: As indicated on Drawings.
 - b. Depth: As indicated on Drawings.
 - 3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.
 - a. Minimum Base-Steel Thickness: As indicated on Drawings.
 - b. Depth: As indicated on Drawings.
 - 4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.
 - a. Minimum Base-Steel Thickness: As indicated on Drawings.
 - 5. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
 - a. Configuration: Asymmetrical.
- G. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. See Drawings.
- H. AUXILIARY MATERIALS
- I. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- J. Isolation Strip at Exterior Walls: Provide the following:
 - 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 - 2. Multilayer Application: As required by horizontal deflection performance requirements unless otherwise indicated.
 - 3. Tile Backing Panels: As required by horizontal deflection performance requirements unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
 - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

- E. Direct Furring:
 - 1. Screw to wood framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Z-Shaped Furring Members:
 - 1. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 - 2. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING 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.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 16 inches o.c.
- 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 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 where required to miss obstructions and 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.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

4. 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.
 5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. 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.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16

SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.

B. Related Requirements:

1. Section 07 92 19 "Acoustical Joint Sealants" for acoustical joint sealants installed in gypsum board assemblies.
2. Section 09 22 16 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
3. Section 09 30 13 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Gypsum wallboard.
2. Gypsum board, Type X.
3. Gypsum ceiling board.
4. Cementitious backer units.
5. Sound-attenuation blankets.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

C. Samples for Initial Selection: For each type of trim accessory indicated.

D. Samples for Verification: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.3 QUALITY ASSURANCE

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. 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. US Corporation
 - 2. National Gypsum Company

2.3 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C1396/C1396M.
 - 1. Thickness: As indicated on the Drawings.
 - 2. Long Edges: Tapered.
- B. Gypsum Board, Type X: ASTM C1396/C1396M.
 - 1. Thickness: As indicated on the Drawings.
 - 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C1396/C1396M.
 - 1. Thickness: As indicated on the Drawings.
 - 2. Long Edges: Tapered.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
 - h. Base-of-Wall Galvanized Moisture Barrier Trim: Galvanized-steel sheet, 2 inches high.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 - 1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
 - 2. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.

- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Sealant: As specified in Section 07 92 19 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: 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 C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: As indicated on Drawings.

2. Type X: As indicated on Drawings.
3. Ceiling Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 INSTALLATION OF TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLATION OF TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
 - 1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
 - 2. Level 5: Where indicated on Drawings.
 - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

SECTION 09 30 13 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Porcelain tile.
2. Glazed wall tile.
3. Tile backing panels.
4. Crack isolation membrane.
5. Metal edge strips.

B. Related Requirements:

1. Section 09 29 00 "Gypsum Board" for cementitious backer units.

1.2 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Face Size: Actual tile size, excluding spacer lugs.
- D. Module Size: Actual tile size plus joint width indicated.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Verification:
1. Full-size units of each type and composition of tile and for each color and finish required.
 2. Full-size units of each type of trim and accessory for each color and finish required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of product.
- C. Product Test Reports: For tile-setting and -grouting products.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Stone thresholds.
 - 2. Waterproof membrane.
 - 3. Crack isolation membrane.
 - 4. Cementitious backer units.
 - 5. Metal edge strips.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

- A. See Drawings for products.

2.4 THRESHOLDS

- A. See Drawings for products.
- B. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
 - 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C1325, Type A, in maximum lengths available to minimize end-to-end butt joints.
 - 1. Thickness: As indicated.

2.6 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.7 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.8 SETTING MATERIALS

- A. See Drawings for products.

2.9 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. See Drawings for products

2.10 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

- B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, 4.0 mils thick.
- C. Metal Edge Strips: See Drawings.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- E. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

2.11 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF CERAMIC TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Exterior tile floors.
 - b. Tile floors in wet areas.
 - c. Tile swimming pool decks.
 - d. Tile floors in laundries.
 - e. Tile floors consisting of tiles 8 by 8 inches or larger.
 - f. Tile floors consisting of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Glazed Wall Tile: 1/8 inch.
2. Porcelain Tile: 1/4 inch.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Metal Edge Strips: Install at locations indicated.

K. Floor Sealer: Apply floor sealer to grout joints according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 INSTALLATION OF TILE BACKING PANEL

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.5 INSTALLATION OF WATERPROOF MEMBRANE

A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.6 INSTALLATION OF CRACK ISOLATION MEMBRANE

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.8 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 09 30 13

SECTION 09 51 23 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical tiles for interior ceilings.
2. Fully concealed, direct-hung, suspension systems.

B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Tiles: Set of full-size Samples of each type, color, pattern, and texture.
2. Exposed Moldings and Trim: Set of 6-inch-long Samples of each type and color.

D. Delegated-Design Submittal: For seismic restraints for ceiling systems.

1. Include design calculations for seismic restraints including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 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-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:
 - a. Lighting fixtures.
 - b. Diffusers.
 - c. Grilles.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
 - g. Perimeter moldings.
7. Show operation of hinged and sliding components adjacent to acoustical tiles.

- B. Qualification Data: For testing agency.
- C. Product Test Reports: For each acoustical tile ceiling, for tests performed by a qualified testing agency.
- D. Evaluation Reports: For each acoustical tile ceiling suspension system, from ICC-ES.
- E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Acoustical Ceiling Units: Full-size tiles equal to 2 percent of quantity installed.
 2. Suspension-System Components: Quantity of each concealed grid and exposed component equal to 2 percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, 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.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: See Drawings.
- B. Source Limitations:
 - 1. Suspended Acoustical Tile Ceilings: Obtain each type of acoustical ceiling tile and its suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic restraints for ceiling systems.
- B. Seismic Performance: Suspended ceilings shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 450 or less.

2.3 ACOUSTICAL TILES AND METAL SUSPENSION SYSTEM

- A. Products: See Drawings.
- B. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E1264 classifications as designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, fully concealed, metal suspension system and accessories of type, structural classification, and finish indicated that complies with applicable requirements in ASTM C635/C635M.

2.4 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 07 92 19 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Testing Substrates: Before adhesively bonding tiles to wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- C. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings according to ASTM C636/C636M, seismic design requirements, and manufacturer's written instructions.
- 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 to structure or to inserts, eye

- screws, or other devices that are secure and appropriate for substrate and that will 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 the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will 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.
- 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 tiles.
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 o.c. and not more than 3 inches from ends. 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. Arrange directionally patterned acoustical tiles as follows:
1. As indicated on reflected ceiling plans.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges of tiles so tile-to-tile joints are interlocked.
1. Fit adjoining tiles to form flush, tight joints. Scribe and cut tiles for accurate fit at borders and around penetrations through ceiling.
 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tiles and moldings, spaced 12 inches o.c.
 3. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections of completed installations of acoustical tile ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion, but no tiles have been installed. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.
 - 1. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 - 2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Acoustical tile ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 09 51 23

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-rubber base.
2. Rubber molding accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products 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.

1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
1. 48 hours before installation.
 2. During installation.
 3. 48 hours after installation.
- B. After installation and 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. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE

- A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Products: See Drawings.
- B. Lengths: Coils in manufacturer's standard length.
- C. Outside Corners: Job formed or preformed.
- D. Inside Corners: Job formed or preformed.

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 resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

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.
 - 1. 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 resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 09 65 13

SECTION 09 65 19 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: Full-size units of each color and pattern of floor tile required.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile 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 floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and 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 tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION FLOOR TILE

- A. Products: See Drawings.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Seamless-Installation Accessories:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 2. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
- D. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile 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.
1. 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 tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F710.
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 floor tile manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain running in one direction.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles 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 F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
 - 2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply

compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply two coat(s).
- E. Joint Sealant: Apply sealant to resilient terrazzo floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
- F. Cover floor tile until Substantial Completion.

END OF SECTION 09 65 19

SECTION 09 65 36 - STATIC-CONTROL RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Static-dissipative, vinyl composition floor tile.

B. Related Requirements:

1. Section 09 65 13 "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with static-control resilient flooring.

1.2 PREINSTALLATION MEETINGS

1.3 ACTION SUBMITTALS

A. Samples for Verification: For each type of static-control resilient flooring, of size indicated below:

1. Floor Tile: 6-by-9-inch units.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for static-control resilient flooring.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of static-control resilient flooring to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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 Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for static-control resilient flooring and seaming method.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store static-control resilient flooring 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.

1. Floor Tile: Store on flat surfaces.

1.9 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 static-control resilient flooring 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 static-control resilient flooring installation.

- D. Close spaces to traffic for 48 hours after static-control resilient flooring installation.

- E. Install static-control resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Static-Dissipative Properties: Provide static-control resilient flooring with static-control properties indicated as determined by testing identical products per test method indicated by an independent testing and inspecting agency.

1. Electrical Resistance: Test per ASTM F150 with 100-V applied voltage.
 - a. Average greater than 1 megohm and less than or equal to 1000 megohms when test specimens are tested surface to ground.
 - b. Average greater than 1 megohm and less than or equal to 1000 megohms when installed floor coverings are tested surface to ground.
 2. Static Generation: Less than 300 V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.
 3. Static Decay: 5000 to zero V in less than 0.25 seconds when tested per FED-STD-101C/4046.1.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 STATIC-DISSIPATIVE RESILIENT FLOOR COVERINGS

- A. Static-Dissipative, Vinyl Composition Floor Tile: ASTM F1066 (vinyl composition floor tile, nonasbestos formulated), Class 2 (through-pattern tile).
1. Products: See Drawings.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor-covering system to ground connection.
- C. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor-covering system to ground connection.
- D. Seamless-Installation Accessories:
1. Heat-Welding Bead: Solid-strand product of manufacturer for heat welding seams.
 - a. Color: As selected by Architect from manufacturer's full range to contrast with floor covering Match floor covering.
 2. Chemical-Bonding Compound: Product of manufacturer for chemically bonding seams.
- E. Floor Polish: Provide protective, static-control liquid floor polish products as recommended by floor-covering manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer and manufacturer's representative 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 or static-control characteristics 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 static-control resilient flooring and electrical continuity of floor-covering systems.
- B. Concrete Substrates: Prepare according to ASTM F710.
 - 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 floor-covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - a. Perform anhydrous calcium chloride test according to ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative-humidity test using in situ probes according to ASTM F2170. Proceed with installation only after substrates have maximum 75 percent relative-humidity level measurement.
- C. 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.
- D. Do not install static-control resilient flooring until it is same temperature as space where it is to be installed.
 - 1. Move static-control resilient flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum substrates to be covered by static-control resilient flooring immediately before installation.

3.3 INSTALLATION, GENERAL

- A. Install static-control resilient flooring according to manufacturer's written instructions.
- B. Embed grounding strips in static-control adhesive. Extend grounding strips beyond perimeter of static-control resilient floor-covering surfaces to ground connections.
- C. Scribe, cut, and fit static-control resilient flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- D. Extend static-control resilient flooring into toe spaces, door reveals, closets, and similar openings. Extend static-control resilient flooring to center of door openings.
- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on static-control resilient flooring as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- F. Install static-control resilient flooring on covers for telephone and electrical ducts, and similar items in installation areas. Maintain overall continuity of color and pattern with pieces of static-control resilient flooring installed on covers. Tightly adhere static-control resilient flooring edges to substrates that abut covers and to cover perimeters.
- G. Adhere static-control resilient flooring to substrates using a full spread of static-control 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.
- H. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with 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.
 - 2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to permanently fuse sections into a seamless floor covering. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on floor-covering surfaces.

3.4 FLOOR-TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so floor tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half floor tile at perimeter.
 - 1. Lay floor tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting floor tiles from cartons in same sequence as manufactured and packaged if so numbered. Discard broken, cracked, chipped, or deformed floor tiles.
 - 1. Lay static-dissipative, vinyl composition floor tiles with grain running in one direction.

3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing agency to test electrical resistance of static-control resilient flooring for compliance with requirements.
 - 1. Arrange for testing after static-control adhesives have fully cured and static-control resilient flooring has stabilized to ambient conditions and after ground connections are completed.
 - 2. Arrange for testing of static-control resilient flooring before and after performing floor polish procedures.
- B. Static-control resilient flooring will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of static-control resilient flooring.
- B. Perform the following operations immediately after completing static-control resilient flooring:
 - 1. Remove static-control adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect static-control resilient flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - 1. Do not wax static-control resilient flooring.
 - 2. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties; ensure static-control resilient flooring surfaces are free from soil, static-control adhesive, and surface blemishes.
 - a. Verify that both floor polish and its application method are approved by manufacturer and that floor polish will not leave an insulating film that reduces static-control resilient flooring's effectiveness for static control.
- D. Cover static-control resilient flooring until Substantial Completion.

END OF SECTION 09 65 36

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular carpet tile.

B. Related Requirements:

1. Section 09 65 13 "Resilient Base and Accessories" and Section 09 65 19 "Resilient Tile Flooring" for resilient wall base and accessories installed with carpet tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include manufacturer's written installation recommendations for each type of substrate.

B. Samples for Verification: 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: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.

C. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. 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.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, 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 10 sq. yd..

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.

1.8 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tiles 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 tiles, install carpet tiles before installing these items.

1.9 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, the following:
 - a. More than 10 percent edge raveling, snags, and runs.
 - b. Dimensional instability.

- c. Excess static discharge.
 - d. Loss of tuft-bind strength.
 - e. Loss of face fiber.
 - f. Delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Products: See Drawings.
- B. Performance Characteristics:
 - 1. Appearance Retention Rating: Heavy traffic, 3.0 minimum according to ASTM D7330.
 - 2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
 - 3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
 - 4. Tuft Bind: Not less than 3 lbf according to ASTM D1335.
 - 5. Delamination: Not less than 3.5 lbf/in. according to ASTM D3936.
 - 6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
 - 7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
 - 8. Noise Reduction Coefficient (NRC): manufacturer's standard according to ASTM C423.
 - 9. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
 - 10. Colorfastness to Light: Not less than 4 after AFU (AATCC fading units) according to AATCC 16, Option E.
 - 11. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
- C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
 - 1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly 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.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive 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 the Carpet and Rug Institute's CRI 104, Section 13.7.
- 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 09 68 13

SECTION 09 72 00 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl wall covering.
- B. Owner-Furnished Materials: See Drawings.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Wallcovering is provided by Owner.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.
- B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion 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 wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 VINYL WALL COVERING

- A. Products: See Drawings. Owner-furnished.

2.2 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
- B. Products: See Drawings. Owner-furnished.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after 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 bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
 - 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
 - 2. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
 - 3. Metals: If not factory primed, clean and apply primer recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
 - 4. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
 - 5. Painted Surfaces: Treat areas susceptible to pigment bleeding.
- D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

- E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.
- F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 WALL-COVERING INSTALLATION

- A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.
- B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
 - 1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.
- D. Install wall covering without lifted or curling edges and without visible shrinkage.
- E. Match pattern 72 inches above the finish floor.
- F. Install seams vertical and plumb at least 6 inches from outside corners and 6 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.
- G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.
- H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.4 CLEANING

- A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 00

SECTION 09 77 13 - STRETCHED-FABRIC WALL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes site-upholstered wall systems.

1.2 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.
- B. SAA: Sound Absorption Average.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include fabric facing, frame edge and trim, core material, and mounting indicated.
- B. Shop Drawings: For each stretched-fabric system.
 - 1. Include plans, elevations, sections, and installation and system details.
 - 2. Include details at head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate frame-edge profile and core materials.
 - 3. Include details at cutouts and penetrations for other work.
 - 4. Include direction of fabric weave and pattern matching.
 - 5. Show sewn-seam locations, types, and methods.
- C. Samples for Initial Selection: For each type of fabric facing.
 - 1. Include Samples of accessories involving color or finish selection.
- D. Samples for Verification: For the following products:
 - 1. Frame System: 12-inch-square Sample(s) showing each edge profile and corner.
 - 2. Core Material: 12-inch-square Sample at corner.
 - 3. Assembled System: Approximately 36 by 36 inches, including joints and seams in mockup.

1.5 INFORMATIONAL SUBMITTALS

- A. 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. Show operation of hinged and sliding components covered by or adjacent to stretched-fabric systems.
- B. Qualification Data: For Installer.
- C. Product Certificates: For each type of stretched-fabric system.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For stretched-fabric systems to include in maintenance manuals. Include fabric manufacturer's written cleaning, stain-removal, restretching, and reupholstering instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product 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, furnish length equal to 10 percent of amount installed, but no fewer than 10 sq. yd., full width of bolt.
 - 2. Framing and Related Installation Items: Furnish manufacturer's full-length units equal to 5 percent of amount installed, but no fewer than five units, including unopened adhesives.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and stretched-fabric system manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install stretched-fabric systems 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 systems until a lighting level of not less than 50 fc is provided on surfaces to receive stretched-fabric systems.
- C. Air-Quality Limitations: Protect stretched-fabric systems from exposure to airborne odors such as tobacco smoke, and install systems under conditions free from odor contamination of ambient air.

1.11 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace components of stretched-fabric systems that fail in performance, 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: Manufacturer's standard.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain stretched-fabric wall systems specified in this Section from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Stretched-fabric wall systems shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency on systems prepared according to ASTM E2573. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 286.

2.3 STRETCHED-FABRIC WALL SYSTEMS

- A. Stretched-Fabric Wall System: Manufacturer's standard system consisting of facing material stretched tightly over a frame and core material and secured in the frame. No alternates are accepted.

1. FabriTRAK by FabriTRAK Systems, Inc
2. Core: TerraCORE Poly.
 - a. Core-Face Layer: Manufacturer's standard impact-resistant, acoustically transparent, copolymer sheet.
 - b. Nominal Core Thickness: Match nominal frame thickness.
3. Core Overlay: Polyester batting Manufacturer's standard thickness.
4. Frame Edge: Manufacturer's profile.
 - a. Nominal Frame Thickness: 1/2 inch .
5. Frame Color: Manufacturer's Standard.
6. Reveals between Panels: reveals as selected by Architect from manufacturer's full range.
7. Facing Material: As indicated on Drawings.
8. Acoustical Performance: Per manufacturer's assembly.

2.4 MATERIALS

- A. Core Materials: Manufacturer's standard.
- B. Frame Construction: Manufacturer's standard, continuous, extruded plastic frame (track).
- C. Facing Material: Fabric from same dye lot; color and pattern matching Architect's samples.

2.5 INSTALLATION MATERIALS

- A. Installation Products: Concealed on back of system, recommended by stretched-fabric system manufacturer to support weight of system, fabric tension, and as follows:
1. Fasteners: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabric, materials, substrates, areas, and conditions, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of stretched-fabric systems.
- 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 stretched-fabric systems according to system manufacturer's written instructions.
 - 1. Provide continuous perimeter frames of each profile indicated, designed to be inconspicuous when covered by fabric facing, with smooth edges, and with surface finish that will not telegraph through fabric facing.
 - 2. Install framing around penetrations.
 - 3. Tightly fit framing to adjacent construction and securely attach to substrate.
 - 4. Install core material with full coverage, flush with face of stretched-fabric system frame.
 - 5. Attach frame and core to substrate with adhesive or fasteners or both to support system and prevent deformation of components.
 - 6. Install stretched-fabric systems level and plumb unless otherwise indicated, true in plane, and with fabric square to the grain.
 - 7. Install jointed panels with as indicated.
 - 8. Provide wood or plywood nailing strips and blocking as indicated on Drawings.
 - 9. Provide continuous 6-inch-wide by 3/4-inch-thick, plywood nailing strips and blocking attached to supporting substrate with suitable fasteners for hanging artwork, centered at 60 inches above finish floor, unless otherwise indicated.
- B. Fabric Installation: Apply fabric monolithically in continuous run over area, without joints or reveals, except where panel joints or midspan frames are indicated.
 - 1. Fabric Direction: Run fabric as indicated.
 - 2. Fabric Sequence: Maintain sequence of fabric drops; match and level fabric pattern and grain.
 - 3. Fabric Alignment: Install fabric with patterns or directional weaves so pattern or weave varies from adjacent panels as indicated on Drawings.

4. Fabric Seams: Sewn seams are not permitted.
5. Fabric Seams: Manufacturer's standard sewn seams, straight and parallel; seam dimensions and locations as indicated on Drawings.
6. Core Overlay: Evenly stretch over core face and edges; free from puckers, ripples, wrinkles, and sags.
7. Stretch and secure fabric to frame edges and so frame and frame attachment method are concealed by fabric unless otherwise indicated.
8. Stretch fabric tightly and square without puckers, ripples, or distortions. Acclimatize and restretch if recommended by stretched-fabric system manufacturer. Repair distortions, wrinkles, and sagging.
9. Trim Strip: Back-wrap trim strip fabric from the fabric-insertion point over the exposed part of the frame edge where indicated, resulting in a contrasting fabric along the edge.

3.4 INSTALLATION TOLERANCES

- A. Edge Straightness: Plus or minus 1/16 inch in 48 inches.
- B. Variation from Level and Plumb: Plus or minus 1/16 inch in 48 inches, noncumulative.
- C. Variation of Joint Width: Not more than 1/16 inch in 48 inches from reveal line, noncumulative.

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.

END OF SECTION 09 77 13

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.

1.2 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

- A. Products: See Drawings.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- C. Colors: As indicated in a color schedule.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Concrete: 12 percent.
 2. Fiber-Cement Board: 12 percent.
 3. Masonry (Clay and CMUs): 12 percent.

4. Wood: 15 percent.
 5. Gypsum Board: 12 percent.
 6. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, 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.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

- H. Aluminum Substrates: Remove loose surface oxidation.
- I. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- J. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply

additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. See Drawings.

END OF SECTION 09 91 23

SECTION 10 28 00 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Warm-air dryers.
3. Childcare accessories.
4. Underlavatory guards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for Project.
5. Manufacturer's warranty.
6. Include electrical characteristics.

B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.

1. Approved full-size Samples will be returned and may be used in the Work.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and

Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for grab bar requirements.

1.6 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.7 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- C. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- D. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- E. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 PERFORMANCE REQUIREMENTS

- 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.

2.3 PUBLIC-USE WASHROOM ACCESSORIES

- A. Products: See Drawings for product specifications.

2.4 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.
 - 1. Grab bars shall be installed at heights and locations as indicated on Drawings, complying with local building code and governing agency having jurisdiction.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 10 28 00

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portable, hand-carried fire extinguishers.
2. Fire protection cabinets.
3. Mounting brackets for fire extinguishers

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rating and classification, construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection specialties.
1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of fire protection specialties indicated.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Size: 6 by 6 inches square.
- E. Product Schedule: For fire protection specialties. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire protection specialties to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
1. Provide fire extinguishers approved, listed, and labeled by FMG.

- C. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- D. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to fire protection specialties including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.5 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet indicated.
 - 1. Valves: Manufacturer's standard.
 - 2. Handles and Levers: Manufacturer's standard.
 - 3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

- B. Multipurpose Dry-Chemical Type in Steel Container Insert drawing designation: UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Steel sheet.
- D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
 - 1. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
- E. Door Material: Steel sheet.
- F. Door Style: Vertical duo panel with frame.
- G. Door Glazing: Tempered float glass (clear).
- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting door pull and friction latch.
 - 2. Provide concealed hinge permitting door to open 180 degrees.
- I. Accessories:
 - 1. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
 - a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door.
 - 2) Application Process: Die cut, pressure-sensitive vinyl letters.
 - 3) Lettering Color: Black.
 - 4) Orientation: Vertical.
- J. Finishes:
 - 1. Manufacturer's standard baked-enamel paint for the following:
 - a. Exterior of cabinet door except for those surfaces indicated to receive another finish.
 - 1) Color: White.

- b. Interior of cabinet and door.

- 1) Color: Match exterior cabinet finish.

2.4 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Horizontal.

2.5 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 - 1. Weld joints and grind smooth.
 - 2. Provide factory-drilled mounting holes.
 - 3. Prepare doors and frames to receive locks.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 - 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

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. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire protection cabinets after assembly.
- 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.

2.7 STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

- 1. Color and Gloss: Match Architect's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
 - 1. Fire Protection Cabinets and Mounting Brackets: 54 inches above finished floor to top of cabinet.
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 00

SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated roller shades with single rollers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Provide: Draper, "Clutch-Operated FlexShade Manual Window Shades"
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Chain-Retainer Type: As indicated.
 - 2. Spring Lift-Assist Mechanisms: Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Shadebands:
 - 1. Shadeband Material: As indicated on the Drawings.
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
 - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - 2. Endcap Covers: To cover exposed endcaps.
 - 3. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - 4. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
 - 5. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
 - 6. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1

- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 - 2. Outside of Jamb Installation: 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.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
 - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
 - 2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

PART 3 - EXECUTION

3.1 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
- B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
- C. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- D. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 12 24 13

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SECTION 12 36 61.16 - SOLID SURFACING COUNTERTOPS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

MasterSpec includes provisions for LEED 2009, LEED v4, IgCC, and Green Globes. Sustainable design requirements may be inserted in the Section Text using the hypertext links.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface material backsplashes.
3. Solid surface material end splashes.
4. Solid surface material apron fronts.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials.

B. Sustainable Design Submittals:

1. [<Double click to insert sustainable design text for certified wood.>](#)
2. [<Double click to insert sustainable design text for adhesives.>](#)
3. [<Double click to insert sustainable design text for composite wood.>](#)

C. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

D. Samples: For each type of material exposed to view.

PART 2 - PRODUCTS

Manufacturers and products listed in this Section are neither recommended nor endorsed by the AIA or Deltek. Before selecting manufacturers and products, verify availability, suitability for intended applications, and compliance with minimum performance requirements. For definitions of terms and requirements for Contractor's product selection, see Section 01 60 00 "Product Requirements."

Product options commonly available from manufacturers are included in square brackets throughout the Section Text. Not every manufacturer listed can provide every option offered; verify availability with

manufacturers. For definitions of terms and requirements for Contractor's product selection, see Section 01 60 00 "Product Requirements."

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.
 - 1. See Drawings for products indicated.
- B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WT's "Architectural Woodwork Standards."
 - 1. Grade: Custom.
- B. Countertops: Thickness as indicated on the Drawings.
- C. Backsplashes: Thickness as indicated on the Drawings.
- D. Joints:

Retain one of two subparagraphs below. First subparagraph is impossible with very large or complex countertops. If retaining second subparagraph and option, indicate joint locations on Drawings.

- 1. Fabricate countertops without joints.
- E. Cutouts and Holes:

Retain "Undercounter Plumbing Fixtures" Subparagraph below for undercounter lavatories and sinks. Shop fabrication usually provides better results, but large openings, such as for kitchen sinks, are better completed after top is in place to avoid possibility of breakage during delivery or installation.

- 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 INSTALLATION

Retain first paragraph below if solid surface countertop is fastened directly to cabinets or other supports.

- A. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer.

Retain first two paragraphs below if solid surface countertop is installed over a plywood or particleboard subtop.

- B. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- C. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions.

Retain first paragraph below unless joints are not allowed.

- D. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
- E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive.
- F. Install aprons to backing and countertops with adhesive.
- G. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. 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.
- H. Apply sealant to gaps at walls; comply with Section 07 92 00 "Joint Sealants."

END OF SECTION 12 36 61.16

SECTION 220130 – CLEANING AND TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 220500 for General Requirements for Plumbing Work.

1.2 SCOPE OF WORK:

- A. This Contractor shall, at his own expense, during the progress of the work or upon its completion, make such tests of his work as are herein specified in accordance with all law governing authorities or as are required by Owner or by state or municipal bureaus having jurisdiction and under their supervision. The Contractor shall provide all apparatus, temporary piping connections or any other requirements necessary for such tests. He shall take all due precautions to prevent damage to building or its contents incurred by such tests, as he will be required to repair and make good, at his own expense any damage so caused. Any leaks, defects or deficiencies discovered as a result of the tests shall be repeated until the test requirements are fully complied with. No caulking of pipe joints to remedy leaks will be permitted.
- B. No work of any nature shall be covered, enclosed or otherwise concealed until properly inspected, tested and approved. Any leaks which develop during any of the tests shall be corrected with new material and make as good as required; said tests shall be repeated until the work is satisfactory to the Architect.
- C. Each separate system with its various components shall be operated by this Contractor for a reasonable length of time to demonstrate the performance of all equipment and piping in accordance with the true intent and purpose of the plans and specifications. All necessary adjustments shall be made to the satisfaction of the Architect.
- D. All motor driven equipment shall be proved operable generally in accordance with the intent of these specifications.
- E. The various water circulating systems shall be cleaned, flushed, filled, purged of air and put into operation before hydronic balancing.

1.3 TESTING AND ADJUSTING:

- A. Water Piping Systems: Water piping systems (including domestic water) shall be properly tested to a hydrostatic pressure of one hundred and fifty pounds (150 psi) per square inch gauge for a period of not less than eight hours. During this test period, all leaks in pipe, fittings and accessories, in the particular piping system which is being tested, shall be stopped and the hydrostatic test shall again be applied. This procedure shall be repeated for an entire eight hour period and no leaks can be found while the system being tested is subject to the pressure mentioned above.

- B. Sanitary Drains: Pipe shall have all outlets temporarily plugged. The pipes shall be filled with water testing the system in sections such that no section shall be tested with less than ten foot (10') head of water. If, after twenty-four hours, the level of the water has been lowered by leakage, the leaks must be found and stopped by this Contractor, and the water level shall again be raised and the test repeated until after twenty-four hour retention period there shall be no perceptible lowering of the water level of the system being tested.
- C. Storm Drains: Pipe shall have all outlets temporarily plugged. The pipes shall be filled with water testing the system in sections such that no section shall be tested with less than ten foot (10') head of water. If, after twenty-four hours, the level of the water has been lowered by leakage, the leaks must be found and stopped by this Contractor, and the water level shall again be raised and the test repeated until after twenty-four hour retention period there shall be no perceptible lowering of the water level of the system being tested.
- D. Gas Piping Systems: The low pressure gas piping shall be subjected to an air pressure test of not less than ten pounds (10 lbs.) per square inch gauge pressure. The test pressure shall be held for a minimum of fifteen (15) minutes, with no perceptible drop in pressure. For piping carrying gas at pressures in excess of fourteen inches (14") of water column pressure, the test pressure shall not be less than sixty pounds (60 lbs.) per square inch and shall be held for a minimum of thirty (30) minutes, with no perceptible drop in pressure.

1.4 CLEANING OR STERILIZATION:

- A. After completion of the pressure testing, the new domestic water piping systems with attached equipment shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. The sterilization solution shall be allowed to remain in the system for a period of eight (8) hours, during which time all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million.

END OF SECTION 220130

SECTION 220500 - BASIC PLUMBING MATERIALS AND METHODS

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. It is the intent of the Contract Documents to provide an installation complete on every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as provide material and equipment usually provided with such systems or required to complete the installation.
- B. This Section includes the following basic mechanical materials and methods to complement other Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Concrete base construction requirements.
 - 3. Escutcheons.
 - 4. Dielectric fittings.
 - 5. Flexible connectors.
 - 6. Mechanical sleeve seals.
 - 7. Equipment nameplate data requirements.
 - 8. Labeling and identifying mechanical systems and equipment is specified in 230553 Section "Mechanical Identification."
 - 9. Nonshrink grout for equipment installations.
 - 10. Field-fabricated metal and wood equipment supports.
 - 11. Installation requirements common to equipment specification sections.
 - 12. Cutting and patching.
 - 13. Touchup painting and finishing.

1.3 CODES, FEES, PERMITS, STANDARDS AND INSPECTIONS:

- A. All work performed under these Specifications shall be in strict accordance with all applicable City, County, State and National Codes, Specifications and Ordinances, and in accordance with all Utility Company regulations.
- B. Refer to Conditions of the Contract for payment of fees and permits.
- C. All materials and workmanship shall comply with all applicable state and national codes, specifications and specified industry standards.

- D. The drawings and these specifications are intended to comply with all the above mentioned rules and regulations, however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect in writing of said discrepancies and apply for an interpretation and, unless an interpretation is offered in writing by the Architect, the applicable rules and regulations shall be complied with as a part of the contract.
- E. In case of difference between building codes, specifications, state laws, industry standards and the Contract Documents, the most stringent shall govern.

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, 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 duct shafts.
- 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. Furnish: Pay for and deliver to the jobsite.
- G. Install: Fix permanently in place; make all necessary connections as related to all trades involved, place in operation, and test.
- H. Replace: Remove and install.
- I. Relocate: Remove and install.
- J. Contractor: Contractor responsible for all trades under the specifications covered by this Division.
- K. Work: Labor and/or materials accruing in the provision of a system as defined by the drawings and these specifications.
- L. Store: Provide an environmentally controlled space to protect the stored equipment from damage prior to installation.
- M. Remove: De-energize, disconnect, and de-commission the designated equipment as related to the trades required to take the equipment out of service. This shall include transporting the equipment to an off-site location as required by authorities having jurisdiction and regulatory agencies, unless directed otherwise by the Architect.

N. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

O. The following are industry abbreviations for rubber materials:

1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.5 SUBMITTALS

- A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
- B. Shop Drawings: Detail fabrication and installation for supports and anchorage for mechanical materials and equipment.
- C. Coordination Drawings shall include the following:
1. Access panel and door locations.
 2. Mechanical Room and equipment mounted inside and outside the building layout drawings.
 3. Piping hanging and supporting details.
 4. Clearances for installing and maintaining insulation.
 5. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 6. Equipment and accessory service connections and support details.
 7. Exterior wall and foundation penetrations.
 8. Fire-rated wall and floor penetrations.
 9. Sizes and location of required concrete pads and bases.
 10. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 11. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

1.6 QUALITY ASSURANCE

- A. Comply with the applicable ASME Standards for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Materials shall be new and of the quality specified. All materials shall be free from defects at the time of installation. Materials or equipment damaged in shipment or otherwise damaged

shall NOT be repaired at the jobsite, but shall be replaced with new materials.

- C. Equipment installed shall have local representation; local factory authorized service, and a local stock of repair parts, within 100 miles of the Project site.
- D. Comply with requirements of authorities having jurisdiction.
- E. All work shall be performed in the best and most workmanlike manner by mechanics skilled in their respective trades and properly licensed.
- F. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design requirements.

1.7 PRODUCT UNIFORMITY

- A. In order to insure an integrated mechanical system providing ease of maintenance, operation, and repair, similar types of equipment shall be provided by a single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes, tubes, and ductwork with factory or shop applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes, tubes and ducts from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified elsewhere in the contract documents.
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.10 COORDINATION

- A. Contractor shall be responsible for detailing, coordinating and fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to provide proper grading of lines, to avoid all obstructions and to conform to the details of the installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated satisfactory operating installation, furnishing all necessary pilot lines and control lines whether indicated on the drawings or not. At no additional cost to the Owner, make all changes or additions to materials and/or equipment necessary to accommodate structural and architectural conditions.
- B. The drawings do not give exact details as to hanging methods of pipes, ducts, materials, etc. Contractor shall refer to the Architectural and Structural Drawings for exact details but without exception all hangers or channels installed under this division of these specifications and spanning between framing members shall be secured to the building structure.
- C. The drawings do not give exact details as to elevations of pipe lines nor do they show exact locations of pipe to scale. Piping elevations shall be handled by giving precedence to pipes which require a stated grade for proper operation. Sewer piping shall take precedence over water pipes in determination of elevations. In all cases, pipes requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Before installation of piping systems, the Contractor shall refer to the Construction as it is then in progress and determine the exact required locations of these systems in conjunction with advice from the representative of the Architect and/or Owner. Devices necessary for installation and support of pipes, and equipment (such as sleeves, inserts, etc.) shall be located and installed as the construction progresses in order to allow completion of each phase of the work in the proper sequence. Drawings showing the extent and arrangement of the work of a particular trade shall be used together with drawings showing extent and arrangement of work of other trades to insure that the Contractor in laying out and installing his work shall do so in a manner such that the work of the several trades may progress in the most direct, workmanlike harmonious manner.
- D. Contractor shall be responsible for the proper location and size of slots, holes or openings in the building structure, and for the correct location of pipe sleeves. The drawings indicate the extent and general arrangement of the various systems, but if any departures from these drawings are deemed necessary by the Contractor, descriptions of these departures and a statement of the reasons therefore, shall be submitted to the Architect as soon as practicable.

- E. In general, piping and ductwork in finished areas of the building shall be installed and concealed in chases, furrings, and above suspended ceilings, unless noted and directed otherwise. Should any conditions arise which would cause any piping or ductwork to be exposed in finished areas, it shall be immediately called to the Architect's attention and correction of the discrepancy shall be made in accordance with the Architect's decision. In unfinished spaces such as equipment rooms, all pipe and ductwork shall be installed as high as possible and shall be installed to a continuous grade and shall be square to the building and securely supported. Piping shall be grouped wherever it is feasible to do so.
- F. Equipment shall be installed in such a manner to make oiling devices and parts (such as filters, drives, bearings, etc.) requiring service and maintenance readily accessible.
- G. All pipe shall be cut accurately to measurements established at the building and shall be installed without springing or forcing. All ducts and pipes exposed in machinery and equipment rooms shall be installed parallel to the building planes, except that the lines shall be sloped to obtain the proper pitch. Piping and ducts above furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed during construction until the systems are completed with final connection.
- H. The construction details of the building are illustrated on the Architectural and Structural Drawings. For new construction, place all inserts to accommodate the ultimate installation of pipe hangers in the forms before concrete is poured and set sleeves in forms before construction. For existing construction, all required inserts shall be "drilled-in" and all openings required through concrete or masonry shall be "saw-cut" or "core drilled" with tools specifically designed for this purpose.
- I. The plans do not give exact details as to elevations of lines, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other location details. Carefully lay out work at the site to conform to the Architectural and Structural conditions, to provide proper grading of lines, to avoid all obstructions, to conform to the details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated satisfactory operation installation.
- J. The plans do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building and in cooperation with other trades. Minor relocations necessitated by the conditions at the site or directed by the Owner shall be made without additional cost to the Owner.
- K. Contractor shall supply and set in place waterproof flashings where pipes pass through roofs. The final installation of the flashings shall be coordinated with the roofing contractor.
- L. Locations and elevations of the various utilities, included within the scope of the work, have been obtained from utility maps and/or other substantially reliable sources and are offered separate from the contract documents as a general guide only, without guarantee as to accuracy. The Contractor shall examine the site and shall verify to his own satisfaction the size, location and elevations of all utilities and shall adequately inform himself of their relation with the work before entering into a contract.

1.11 EQUIPMENT CONNECTIONS:

- A. It is the intent of the Contract Documents that all systems and equipment being furnished under the air conditioning and/or plumbing sections of these specifications shall be provided with all necessary utility connections completed to allow safe and proper operation of said systems. Where it is necessary to make final connections to items of equipment specified under other sections of these Specifications, all such work shall be performed in a neat and workmanlike manner and all materials shall be of quality and finish normally used for such installation.

1.12 EXCAVATION AND BACKFILL:

- A. Provide all necessary excavation and backfill for the installation of the plumbing, heating, air conditioning, and ventilating work in accordance with the project document requirements.
- B. The Contractor shall be responsible for submitting a site specific trench safety system prepared by a registered professional engineer which meets OSHA standards and any additional state and local standards.
- C. Trenches for all underground piping shall be excavated to the required depths. The bottoms of the trenches shall be tamped hard and graded to secure maximum fall. Bell holes shall be excavated to assure the pipes resting for its entire length on solid ground. Should rock be encountered, it shall be excavated to a depth 6" below the bottom of the pipe and shall be backfilled to the proper grade with pea gravel thoroughly tamped. Pipe laid in trenches dug in fill shall be supported down to load bearing undisturbed soil. When the pipes have been inspected and approved by inspecting authorities, the trenches shall be backfilled. The trenches shall be carefully backfilled with select fill material or pea gravel to a depth of six (6) inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials if of earth, loam, sand or gravel, free of large clods and with rocks no larger than 1-1/2" in diameter. Backfill shall be installed in layers 12" deep, adequately tamped and wetted down or flushed before the second layer of earth is laid in place.
- D. Underground pipes and conduits shall be installed below the local frost-line depth but in no case shall the bury depth be less than 24 inches below finished grade.
- E. Obtain soil report from Owner and evaluate existing conditions, and make allowance to provide filled and compacted areas relating to plumbing work.

1.13 FLAME SPREAD PROPERTIES OF MATERIALS:

- A. All materials and adhesives used for air conditioning filters, acoustical lining and insulation, etc. shall conform to NFPA and UL life and safety and flame spread properties of materials. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating for these classifications as listed for the basic materials, the finishes, adhesives, etc., specified for each system and shall be such when completely assembled.

1.14 FLOOR, CEILING AND WALL PLATES:

- A. In each finished space, furnish a chromium plated sectional escutcheon on each pipe, or hanger

rod penetrating a wall, floor or ceiling. Escutcheons shall be sized to fit snugly to all lines and where the lines are insulated, the escutcheons shall fit snugly over the insulation. Where required, these plates shall be provided with set screws so that they fit snugly against the finished surface.

1.15 OPERATION PRIOR TO COMPLETION

- A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so providing that he properly supervises the 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, and properly adjust the operation of the equipment before final acceptance by the Owner.
- C. Immediately prior to owner move-in, all equipment, piping, and all other plumbing-related devices will be cleaned, adjusted and commissioned by this contractor. The warranty period shall begin upon completion of the work above, demonstration of complete and operating systems, and Substantial Completion certified by the architect of the entire Project.

1.16 PROJECT RECORD DOCUMENTS AND RECORDS FOR OWNER

- A. Project record documentation and records for the Owner shall be as specified in the project documents General Requirements Section.
- B. In addition to the project documents requirements of these specification provide the following minimum items:
 - 1. Operations & Maintenance Manuals: Include, as appropriate to each item, sufficient information to provide for the Owner's operation and maintenance of equipment furnished.
 - 2. As-Built: Include neatly marked set of reproducible drawings showing "As Installed" work.
 - 3. Contacts: Include with each product, name, address, and telephone numbers, of installing contractor, factory and local service representative.
 - 4. Instructions of Owner's Personnel: Prior to final inspection and acceptance, fully instruct the Owner's designated operating and maintenance personnel in the operating and performance of the equipment furnished.
 - 5. Warranties: Include warranty information properly executed by respective manufacturers, suppliers, or sub-contractors for the equipment and system furnished.

1.17 SAFETY GUARDS

- A. Contractor shall furnish and install all safety guards required. All electrical equipment, belt driven equipment, projecting shafts and other rotating or energized parts shall be properly enclosed or adequately guarded.

1.18 SPACE AND EQUIPMENT ARRANGEMENT

- A. Size of equipment shown by the drawings is based on the dimensions of a particular manufacturer. Where other manufacturers are acceptable, it is the responsibility of the contractor to determine if the equipment he proposes to furnish will fit the space.
- B. Equipment shall be installed in a manner that will permit access to all surfaces requiring access. Proper clearances shall be maintained to meet all safety and operating requirements or codes and standards.

1.19 PROTECTION OF MATERIALS AND APPARATUS

- A. At all times take such precautions as may be necessary to properly protect the electrical apparatus from damage. This shall include the creation of all required temporary shelters and environmental control to adequately protect any electrical apparatus. Electrical apparatus shall be cribbed up from the floor and covered with protective coverings where necessary to protect the apparatus from damage.
- B. As required, 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 is not in a space that is continuously under normal control of temperature and humidity.
- C. Damage resulting from failure to comply with this requirement will be considered justification for rejection of the damaged apparatus and requiring its complete replacement by the Contractor.

1.20 INSPECTION OF BUILDING SITE:

- A. Contractor shall visit the site, verifying all existing items indicated on plans and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil, conditions, and local requirements. The submission of bids shall be deemed evidence of each visit. All Proposals shall take these existing conditions into consideration, and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.

1.21 ROOF PENETRATIONS:

- A. Roof openings shall be made in accordance with the project documents.

1.22 ACCEPTABLE MANUFACTURERS

- A. Specifications and drawings are intended to indicate a minimum standard of quality for materials and equipment which is established by the listing of manufacturer's names and catalog numbers and/or the defining of the technical characteristics in detail or by referenced standards. Materials and equipment that do not comply with these standards of quality will NOT be considered.

- B. Contractor shall be responsible to identify any deviation of the submittal from the specified manufacturer, product, equipment or material. Approval by the Architect shall NOT be considered as acceptance of the deviation unless specifically identified and acknowledged by the Architect during the submittal process.
- C. Where only one manufacturer's name is listed in the equipment specification, other manufacturers of similar characteristics and of equal or better performance capacities may be considered for "or equal" approval by the Architect. Where more than one manufacturer is listed in the equipment specification, only those named manufacturers will be considered.
- D. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended, within the guarantee or warranty period, this material or equipment shall be replaced with the material or equipment specified at no cost to the Owner.

PART 2 - PRODUCTS

2.1 SLEEVE

- A. Above grade and dry location sleeves shall be constructed from 20 gauge galvanized steel and shall be flush on both sides of wall surface penetrated. The sleeves shall be sized to allow free passage of the conduit to be inserted, and when this conduit is to be provided with firestopping, the sleeves shall be large enough to pass the conduit and install the necessary firestopping material. Floor sleeves shall extend two (2") inches above the finished floor slab elevation.
- B. Sleeves passing through walls or floors (except slab on grade) at or below finished grade elevation and/or in moist areas shall be constructed of galvanized steel, schedule 40 pipe, and shall be designed with suitable flange in the center of the floor or wall to form a waterproof passage. After the conduits have been installed in the sleeves, insure a waterproof penetration by the use of a "Link-Seal" by Thunderline or "Pipe-Linx" by Mason, Inc. wall sleeve, or shall fabricate a sleeve in accordance with recommendation and sizing furnished by the Thunderline Corporation or Mason, Incorporated.
- C. Sleeves passing through fire rated walls or floors shall be sealed with an approved fire-stop material, after installation of the conduit, such that the fire rating of the wall or floor is not degraded.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dielectric Unions:
 - a. Watts Industries, Inc.; Water Products Div.
 - b. Capitol Manufacturing Co.
 - c. Zurn Industries, Inc.; Wilkins Div.

2. Dielectric Flanges:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Watts Industries, Inc.; Water Products Div.
3. Dielectric-Flange Insulating Kits:
 - a. Calpico, Inc.
 - b. Central Plastics Co.
4. Dielectric Couplings:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
5. Dielectric Nipples:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Perfection Corp.
 - c. Victaulic Co. of America.
6. Metal, Flexible Connectors:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Hyspan Precision Products, Inc.
 - c. Metraflex Co.
7. Mechanical Sleeve Seals:
 - a. Calpico, Inc.
 - b. Metraflex Co.
 - c. Thunderline/Link-Seal.

2.3 PIPE AND PIPE FITTINGS

- A. Refer to individual piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: Pipe threads shall comply with the applicable ASME standards for factory-threaded pipe and pipe fittings.

2.4 JOINING MATERIALS

- A. Refer to individual 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. Comply with the applicable ASME standards, 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 (for plumbing applications) Class 150 (for hydronic applications), cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Comply with the applicable AWWA standards, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: Comply with the applicable ASME standards, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: Comply with the applicable ASTM standards.
1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
 3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
 4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
 5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- F. Brazing Filler Metals: Comply with the applicable AWS standards.
1. BCuP Series: Copper-phosphorus alloys.
 2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with applicable AWS standards for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements: Manufacturer's standard solvent cements for the following:
1. ABS Piping: Comply with the applicable ASTM standards.
 2. CPVC Piping: Comply with the applicable ASTM standards
 3. PVC Piping: Comply with the applicable ASTM standards. Include primer according to ASTM standards.
 4. PVC to ABS Piping Transition: Comply with the applicable ASTM standards.
- I. Plastic Pipe Seals: Comply with the applicable ASTM standards, elastomeric gasket.
1. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: Comply with the applicable AWWA standards, rubber gasket, carbon-steel bolts and nuts.

2.5 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to

prevent galvanic action and stop corrosion.

- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Provide separate companion flanges and steel bolts and nuts for 150 or 300-psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- H. 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 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2 inch NPS (DN50) and Smaller: Threaded.
 - 2. 2 ½ inch NPS (DN65) and Larger: Flanged
 - 3. Option for 2 ½ Inch NPS (DN65) and Larger: Grooved for use with keyed couplings.
- B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Included copper-tube ends or bronze flanged ends braze welded to hose.
- C. 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.
- D. 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.

- E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig (860-kPa) minimum working pressure rating at 220 deg F (104 deg C). Units may be straight or elbow type, unless otherwise indicated.

2.7 PIPING SPECIALTIES

- A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 - 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 - 2. OD: Completely cover opening.
 - 3. Cast Brass: One piece, with set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
 - 4. Cast Brass: Split casting, with concealed hinge and set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
 - 5. Stamped Steel: One piece, with set screw and chrome-plated finish.
 - 6. Stamped Steel: One piece, with spring clips and chrome-plated finish.
 - 7. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
 - 8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
 - 9. Stamped Steel: Split plate, with exposed-rivet hinge, set screw, and chrome-plated finish.
 - 10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
 - 11. Cast-Iron Floor Plate: One-piece casting.

2.8 GROUT

- A. Nonshrink, Nonmetallic Grout: Comply with the applicable ASTM standards.
 - 1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psig, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise.
Individual piping Sections specify unique piping installation requirements.

- B. General Locations and Arrangements: 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 Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's written instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- N. Install sleeves for pipes passing through concrete and masonry walls, 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. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Build sleeves into new walls and slabs as work progresses.

3. Install sleeves 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 6-inch NPS.
 - b. 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 7 for flashing.
 - c. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants.
 5. Use neutral-curing silicone sealant, unless otherwise indicated.
- O. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve 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** in diameter and larger.
 3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for **1-inch** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- T. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

5. Threaded Joints: Thread pipe with tapered pipe threads according to the applicable ASME standards. 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:
 - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - c. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. 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.
 6. Welded Joints: Construct joints according to the applicable AWS standards, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
 8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
 - a. Comply with the applicable ASTM standards for safe-handling practice of cleaners, primers, and solvent cements.
 - b. ABS Piping: Comply with the applicable ASTM standards.
 - c. CPVC Piping: Comply with the applicable ASTM standards.
 - d. PVC Pressure Piping: Comply with the applicable ASTM standards.
 - e. PVC Nonpressure Piping: Comply with the applicable ASTM standards.
 - f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to the applicable ASTM standards.
 9. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to the applicable ASTM standards procedures and manufacturer's written instructions.
 - a. Plain-End Pipe and Fittings: Use butt fusion.
 - b. Plain-End Pipe and Socket Fittings: Use socket fusion.
- U. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
 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.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. 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. Extend grease fittings to accessible locations.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.3 PAINTING AND FINISHING

- A. Refer to project manual for paint materials, surface preparation, and application of paint.
- B. Apply paint to exposed piping according to the following, unless otherwise indicated:
 - 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 - 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
- C. Do not paint piping specialties with factory-applied finish.
- D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than **4 inches** larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in project manual.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS Standards, "Structural Welding Code--Steel.

3.6 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.7 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

3.8 OWNER FURNISHED EQUIPMENT

- A. Where the Owner has elected to procure some equipment for the project, it is the intent of these specifications that the Contractor shall accept responsibility of this equipment and provide the following:
 - 1. Coordinate shop drawing preparation.
 - 2. Provide supervision to coordinate shipping and accept delivery.

3. Provide power and control wiring to provide functions in accordance with these specifications.
 4. Deliver the equipment to the Owner in a workable, operating, and tested condition.
 5. Provide supervision to coordinate factory and on-site testing, start-up, and commissioning in accordance with these specifications.
 6. Provide supervision to coordinate Owner training and preparation of O&M Manuals.
- B. Coordinate list of equipment provided by Owner with Owner.

END OF SECTION 220500

SECTION 220523 – VALVES (PLUMBING)

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 general duty valves common to several mechanical piping systems.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Special purpose valves are specified in Division 23 piping system Sections.
 - 2. Valve tags and charts are specified in Division 22 Section "Plumbing Identification."

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.
- C. Maintenance data for valves to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section "Materials and Equipment," under "Source Limitations" Paragraph.

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 globe and gate 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 indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in 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. Gate Valves:
 - a. Crane Company; Valves and Fitting Division.
 - b. NIBCO Inc.
 - c. Jomar Valve (Italy)
 2. Ball Valves:
 - a. NIBCO Inc.
 - b. Stockham Valves & Fittings, Inc.
 - c. Jomar Valve (Italy)
 3. Plug Valves:
 - a. NIBCO Inc.
 - b. Stockham Valves & Fittings, Inc.
 - c. Dezurik
 4. Butterfly Valves:
 - a. Crane Company; Valves and Fitting Division.
 - b. NIBCO Inc.
 - c. Jomar Valve (Italy)

5. Swing Check Valves:

- a. Crane Company; Valves and Fitting Division.
- b. NIBCO Inc.
- c. Jomar Valve (Italy)

2.2 BASIC, COMMON FEATURES

- A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.
 1. Nonrising stem valves may be used where headroom prevents full extension of rising stems.
- B. Materials: All valves shall be certified lead-free.
- C. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.
- D. Sizes: Same size as upstream pipe, unless otherwise indicated.
- E. Operators: Use specified operators and handwheels, except provide the following special operator features:
 1. Handwheels: For valves other than quarter turn.
 2. Lever Handles: For quarter-turn valves **6 inches** and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
- F. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

2.3 GATE VALVES

- A. Gate Valves, **2-1/2 Inches** and Smaller: Class 125, **200-psi** cold working pressure (CWP), or Class 150, **300-psi** CWP; Cast-bronze body and bonnet, solid-bronze wedge, non-rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel, lead-free.

2.4 BALL VALVES

- A. Ball Valves, **4 Inches** and Smaller: Class 150, **600-psi** CWP, bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for **1/2-inch** valves and smaller and conventional port for **3/4-inch** valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections, lead-free:
 1. Operator: Steel handwheel.
 2. Operator: Vinyl-covered steel lever handle.
 3. Operator: Vinyl-covered steel tee handle.

4. Operator: Lever operators with lock.
5. Stem Extension: For valves installed in insulated piping.
6. Memory Stop: For operator handles.

2.5 PLUG VALVES

- A. Plug Valves: **175-psi** CWP, ASTM A 126 cast-iron body and bonnet, cast-iron plug, Buna N, Viton, or teflon packing, flanged or grooved end connections:
1. Operator: Lever.
 2. Operator: Square head with 1 wrench for every 10 valves.

2.6 BUTTERFLY VALVES

- A. Butterfly Valves: **200-psi** CWP, **150-psi** maximum pressure differential, cast-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals, wafer, lug, or grooved style:
1. Disc Type: Stainless steel
 2. Operator for Sizes **2 Inches** to **6 Inches**: Standard lever handle.

2.7 CHECK VALVES

- A. Swing Check Valves, **2-1/2 Inches** and Smaller: Class 125, **200-psi** CWP, or Class 150, **300-psi** CWP; horizontal swing, Y-pattern, cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections, lead-free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until 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 from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- 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. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
 - 2. Wafer Check Valves: Horizontal or vertical position, between flanges.
 - 3. Lift Check Valve: With stem upright and plumb.

3.3 SOLDERED CONNECTIONS

- A. Cut tube square and to exact lengths.
- B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.
- C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- D. Open gate and globe valves to fully open position.
- E. Remove the cap and disc holder of swing check valves having composition discs.
- F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.
- G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

- A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.
- C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.6 VALVE END SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Copper Tube Size, 2-1/2 Inches and Smaller: Solder ends, except provide threaded ends for heating hot water and low-pressure steam service.
 - 2. Steel Pipe Sizes, 2-1/2 Inches and Smaller: Threaded or grooved end.
 - 3. Steel Pipe Sizes, 3 Inches and Larger: Grooved end or flanged.

3.7 APPLICATION SCHEDULE

- A. General Application: Use ball valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
 - 1. Gate Valves: Class 125, bronze or cast-iron body to suit piping system.
 - 2. Ball Valves: Class 150, CWP, with stem extension.
 - 3. Plug Valves: Neoprene-faced plug, Buna N packing.
 - 4. Globe Valves: Class 125, bronze or cast-iron body to suit piping system, and bronze or teflon disc.

5. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze or elastomer-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
6. Bronze Swing Check: Class 125, with rubber seat.
7. Check Valves: Class 125, swing or wafer type as indicated.

3.8 ADJUSTING

- A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 220523

SECTION 220529 – PLUMBING SYSTEM HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS Standards.

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports, channel support systems and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code.
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.

1. 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 hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Pipe Hangers:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.
 - c. PHD Manufacturing, Inc.
 - d. Piping Technology & Products, Inc.
 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. Unistrut Corp.
 3. Thermal-Hanger Shield Inserts:
 - a. PHS Industries, Inc.
 - b. Pipe Shields, Inc.
 - c. Rilco Manufacturing Co., Inc.
 4. Powder-Actuated Fastener Systems:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components. MSS Standards, Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
 1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- B. Channel Support Systems: factory-fabricated components for field assembly.
 - 1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
 - 1. Material for Insulated Cold Piping: Applicable ASTM Standards, Type I calcium silicate with vapor barrier.
 - 2. Material for Insulated Hot Piping: Water-repellent-treated, applicable ASTM Standards, Type I calcium silicate.
 - 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 - 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 - 5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Anchor fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- C. Structural Steel: Applicable ASTM standard steel plates, shapes, and bars, black and galvanized. All exterior pipe support systems shall be zinc rich hot dip galvanized.
- D. Grout: Applicable ASTM standards, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Non-staining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS standards for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS standards): For suspension of non0insulated or insulated stationary pipes, **NPS 1/2 to NPS 30**.
 2. Yoke-Type Pipe Clamps (MSS standards): 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 standards): 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 standards): For suspension of cold and hot pipes, **NPS 1/2 to NPS 24**, if little or no insulation is required.
 5. Pipe Hangers (MSS standards): 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 standards): For suspension of non0insulated stationary pipes, **NPS 3/4 to NPS 8**.
 7. Adjustable Steel Band Hangers (MSS standards): For suspension of non0insulated stationary pipes, **NPS 1/2 to NPS 8**.
 8. Adjustable Band Hangers (MSS standards): For suspension of non0insulated stationary pipes, **NPS 1/2 to NPS 8**.
 9. Adjustable Swivel-Ring Band Hangers (MSS standards): For suspension of non0insulated stationary pipes, **NPS 1/2 to NPS 2**.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS standards): For suspension of non0insulated stationary pipes, **NPS 3/8 to NPS 8**.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS standards): For suspension of non0insulated stationary pipes, **NPS 3/8 to NPS 3**.
 12. U-Bolts (MSS standards): For support of heavy pipe, **NPS 1/2 to NPS 30**.
 13. Clips (MSS standards): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS standards): 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 standards): 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 standards): 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 standards): For suspension of pipes, **NPS 1 to NPS 30**, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS standards): 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 standards): 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 standards): 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 standards): 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.
- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS standards): For support of pipe risers, **NPS 3/4 to NPS 20**.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS standards): For support of pipe risers, **NPS 3/4 to NPS 20**, if longer ends are required for riser clamps.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS standards): For adjustment up to **6 inches** for heavy loads.
 2. Steel Clevises (MSS standards): For **120 to 450 deg F** piping installations.
 3. Swivel Turnbuckles (MSS standards): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS standards): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS standards): For **120 to 450 deg F** piping installations.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS standards): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS standards): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS standards): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS standards): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS standards): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS standards): For structural shapes.
 7. Top-Beam Clamps (MSS standards): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS standards): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS standards): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS standards): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS standards): 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 standards): **750 lb.**
 - b. Medium (MSS standards): **1500 lb.**
 - c. Heavy (MSS standards): **3000 lb.**
 13. Side-Beam Brackets (MSS standards): For sides of steel or wooden beams.
 14. Plate Lugs (MSS standards): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS standards): For supporting piping systems subject to linear horizontal movement where head room is limited.

- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS standards): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS standards): Of length recommended by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS standards): Where indicated to control piping movement.
 2. Spring Cushions (MSS standards): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 3. Spring-Cushion Roll Hangers (MSS standards): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS standards): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS standards): 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 standards): 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 standards): 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 standards): Mounted horizontally.
 - b. Vertical (MSS standards): Mounted vertically.
 - c. Trapeze (MSS standards): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS Standards. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

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 Standards, steel shapes selected for loads being supported. Weld steel according to AWS Standards.
- C. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
- D. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- F. 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.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME Standards," is not exceeded.
- I. Insulated Piping: Comply with the following:
1. Attach clamps and spacers to piping.
 - a. Piping Operated Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operated 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 Standards.
 2. Install thermal-hanger shield inserts. Include steel weight-distribution plate for pipe **NPS 4** and larger if pipe is installed on rollers.
 3. Shield Dimensions for Pipe: Not less than the following:
 - a. **NPS 1/4 to NPS 3-1/2: 12 inches** long and **0.048 inch** thick.
 - b. **NPS 4: 12 inches** long and **0.06 inch** thick.
 - c. **NPS 5 and NPS 6: 18 inches** long and **0.06 inch** thick.
 - d. **NPS 8 to NPS 14: 24 inches** long and **0.075 inch** thick.
 - e. **NPS 16 to NPS 24: 24 inches** long and **0.105 inch** thick.
 4. Pipes **NPS 8** and Larger: Include wood inserts.
 5. Insert Material: Length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 standard 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.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal are specified in Division 9 Section "Painting".
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM Standards.

END OF SECTION 220529

SECTION 220553 - PLUMBING IDENTIFICATION

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 mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Valve tags.
7. Valve schedules.
8. Warning tags.

1.3 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. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME Standards, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data: Name and plan number.
 - 3. Size: **2-1/2 by 4 inches** for control devices and equipment.
- C. Equipment Signs: Comply with ASTM standards, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Data: Instructions for operation of equipment and for safety procedures.
 - 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
 - 3. Thickness: **1/8 inch**, unless otherwise indicated.
 - 4. Thickness: **1/16 inch** for units up to **20 sq. in.** or **8 inches** in length, and **1/8 inch** for larger units.
 - 5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- D. Access Panel and Door Markers: **1/16-inch** thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide **1/8-inch** center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME Standards, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than **6 Inches**: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, **6 Inches** and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- C. Plastic Tape: Continuously printed, vinyl tape at least **3 mils** thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, **6 Inches** or Larger: **1-1/2 inches** minimum.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with **1/4-inch** letters for piping system abbreviation and **1/2-inch** numbers, with approved numbering scheme. Provide **5/32-inch** hole for fastener.
1. Material: 0.032-inch thick brass.
 2. Valve-Tag Fasteners: Brass S-hook.

2.4 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: Comply with ASTM standards, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Water Heaters
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Meters, gages, thermometers, and similar units.
 - c. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- D. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
 - 1. Identify mechanical equipment with equipment markers in the following color codes:
 - a. Green: For cooling equipment and components.
 - b. Yellow: For heating equipment and components.
 - c. Orange: For combination cooling and heating equipment and components.
 - d. Brown: For energy-reclamation equipment and components.
 - 2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 4. Include signs for the following general categories of equipment:
 - a. Water Heaters
- E. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 2. Pipes with OD, Including Insulation, Less Than 6 Inches: Use color-coded, adjustable plastic bands at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

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; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections. List tagged valves in a valve schedule.
- B. Valve Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
1. Valve Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. Fire Protection: 1-1/2 inches (38 mm), round.
 - d. Gas: 1-1/2 inches, square.
 2. Valve Tag Color:
 - a. Cold Water: Blue.
 - b. Hot Water: Natural.
 - c. Fire Protection: Red.
 - d. Gas: Green.
 3. Letter Color:
 - a. Cold Water: White.
 - b. Hot Water: Black.

- c. Fire Protection: Black.
- d. Gas: White.

3.5 VALVE SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 ADJUSTING

- A. Relocate plumbing identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

- A. Clean faces of plumbing identification devices.

END OF SECTION 220553

SECTION 220700 - PIPE INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 7 Section "Firestopping" for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Duct Insulation" for insulation for ducts and plenums.
 - 3. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat trace inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties and equipment connections.
 - 6. Application of field-applied jackets.
- C. 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.

1.4 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to applicable ASTM standards, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread rating of 25 or less and smoke-developed rating of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification 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."
- B. Coordinate clearance requirements with piping Installer for insulation application.
- C. Coordinate installation and testing of electric heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Knauf FiberGlass GmbH.
 - c. Owens-Corning Fiberglas Corp.
 - d. Schuller International, Inc.
 - 2. Cellular-Glass Insulation:

- a. Pittsburgh-Corning Corp.
- 3. Flexible Elastomeric Thermal Insulation:
 - a. Armstrong World Industries, Inc.
 - b. Rubatex Corp.
- 4. Polyolefin Insulation:
 - a. Armstrong World Industries, Inc.
 - b. IMCOA.
- 5. Closed-Cell Phenolic-Foam Insulation:
 - a. Kooltherm Insulation Products, Ltd.
- 6. Calcium Silicate Insulation:
 - a. Owens-Corning Fiberglas Corp.
 - b. Pabco.
 - c. Schuller International, Inc.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 - 1. Preformed Pipe Insulation: Comply with applicable ASTM Standards, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 - 2. Blanket Insulation: Comply with applicable ASTM C Standards, Type II, without facing.
 - 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 - 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 - 5. Mineral-Fiber Insulating Cements: Comply with applicable ASTM C Standards.
 - 6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with applicable ASTM Standards.
 - 7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with applicable ASTM C Standards.

- B. Cellular-Glass Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.
 - 1. Preformed Pipe Insulation, with Jacket: Comply with applicable ASTM standards (typical).
- C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge or expanded-rubber materials. Comply with ASTM for tubular materials and sheet materials.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- D. Polyolefin Insulation: Unicellular polyethylene thermal plastic, preformed pipe insulation. Comply with ASTM, except for density.
 - 1. Adhesive: As recommended by insulation material manufacturer.
- E. Closed-Cell Phenolic-Foam Insulation: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C.
- F. Calcium Silicate Insulation: Preformed pipe sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C.
- G. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

- A. General: Comply with applicable ASTM standards.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: White or gray.
- D. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45 and 90-degree, short and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.
- E. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45 and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 2. Adhesive: As recommended by insulation material manufacturer.
- F. Aluminum Jacket: Factory cut and rolled to indicated sizes. Comply with **ASTM**, 3003 alloy, H-14 temper.
1. Finish and Thickness: Corrugated finish, **0.010 inch** thick.
 2. Moisture Barrier: **1-mil** thick, heat-bonded polyethylene and Kraft paper.
 3. Elbows: Preformed, 45 and 90-degree, short and long-radius elbows; same material, finish, and thickness as jacket.
- G. Stainless-Steel Jacket: ASTM, Type 304 or 316; **0.10 inch** thick; and roll stock ready for shop or field cutting and forming to indicated sizes.
1. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and Kraft paper.
 2. Elbows: Gore type, for 45 and 90-degree elbows in same material, finish, and thickness as jacket.
 3. Jacket Bands: Stainless steel, Type 304, **3/4 inch** wide.

2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Woven glass-fiber fabrics, plain weave, presized a minimum of **8 oz. /sq. yd.**
1. Tape Width: 4 inches.
- B. Bands: **3/4 inch** wide, in one of the following materials compatible with jacket:
1. Stainless Steel: ASTM, Type 304; 0.020 inch thick.
 2. Aluminum: **0.007 inch** thick.
- C. Wire: **0.062-inch**, soft-annealed, stainless steel.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- H. Keep insulation materials dry during application and finishing.
- I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- J. Apply insulation with the least number of joints practical.
- K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least **12 inches** from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- O. Apply insulation with integral jackets as follows:
1. Pull jacket tight and smooth.
 2. Circumferential Joints: Cover with **3-inch** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced **4 inches** o.c.
 3. Longitudinal Seams: Overlap jacket seams at least **1-1/2 inches**. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **4 inches** o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
 4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
1. Seal penetrations with vapor-retarder mastic.
 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 3. Extend metal jacket of exterior insulation outside roof flashing at least **2 inches** below top of roof flashing.
 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."
- T. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of **15 to 20 feet** to form a vapor retarder between pipe insulation segments.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at **6 inches** o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least **1 inch**, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least **1 inch** at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 CELLULAR-GLASS INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at **6 inches** o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least **1 inch**, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:

1. Apply pre-molded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
4. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.6 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.7 POLYOLEFIN INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. For split tubes, seal longitudinal seams and end joints with manufacturer's recommended adhesive.
3. For self-adhesive insulation, staple longitudinal seams after sealing. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of the same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- C. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of polyolefin pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.
- D. Apply insulation to valves and specialties as follows:
1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
 2. Apply cut segments of polyolefin pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.8 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION

- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
 3. For insulation with factory-applied jackets, secure laps with outward clinched staples at **6 inches** o.c.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
 4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least **1 inch**, and seal joints with vapor-retarder mastic.

- C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered sections of phenolic-foam insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered segments of phenolic-foam insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.9 CALCIUM SILICATE INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with stainless-steel bands at 12-inch intervals and tighten without deforming insulation materials.
2. Apply two-layer insulation with joints tightly butted and staggered at least **3 inches**. Secure inner layer with **0.062-inch**, soft-annealed, stainless-steel wire spaced at **12-inch** intervals. Secure outer layer with stainless-steel bands at **12-inch** intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to surface of installed insulation. When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least **1 inch**. Apply finish coat of lagging adhesive over glass cloth or tape. Thin the finish coat to achieve smooth finish.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
4. Finish flange insulation the same as pipe insulation.

C. Apply insulation to fittings and elbows as follows:

1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When pre-molded sections of insulation are not available, apply mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.

3. Finish insulation of fittings the same as pipe insulation.

D. Apply insulation to valves and specialties as follows:

1. Apply mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation the same as pipe insulation.

3.10 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.

1. Draw jacket material smooth and tight.
2. Apply lap or joint strips with the same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.

D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.12 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors.
 - 2. Vibration-control devices.
 - 3. Fire-suppression piping.
 - 4. Drainage piping located in crawl spaces, unless otherwise indicated.
 - 5. Below-grade piping, unless otherwise indicated.
 - 6. Chrome-plated pipes and fittings, unless potential for personnel injury.
 - 7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.13 FIELD QUALITY CONTROL

- A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
 - 1. Inspect fittings and valves randomly selected by Architect.
- B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.
- C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.14 INSULATION APPLICATION SCHEDULE, GENERAL

- A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.
- B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.15 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water.
 - 1. Operating Temperature: 60 to 140 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, up to 1" : 1"
 - b. Copper Pipe, 1 ¼" to 2": 1"
 - c. Copper Pipe, 2 ¼" and larger: 1 ½"

4. Field-Applied Jacket: Foil and paper exposed piping only.
 5. Vapor Retarder Required: No.
 6. Finish: None.
- B. Service: Domestic cold water.
1. Operating Temperature: 45 to 60 deg F.
 2. Insulation Material: Mineral fiber
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, All sizes: ½"
 4. Field-Applied Jacket: Foil and paper
 5. Vapor Retarder Required: Yes.
 6. Finish: None.
- C. Service: Rainwater conductors from bottom of the roof slab through all horizontal runs to the connection with the vertical leaders.
1. Operating Temperature: 32 to 100 deg F.
 2. Insulation Material: Mineral fiber
 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Cast Iron Pipe, All sizes: ½"
 4. Field-Applied Jacket: Fitting only [PVC].
 5. Vapor Retarder Required: Yes.
 6. Finish: None.
- D. Service: Roof drain bodies.
1. Operating Temperature: 32 to 100 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: ½"
 4. Field-Applied Jacket: PVC.
 5. Vapor Retarder Required: Yes.
 6. Finish: None.
- E. Service: Sanitary waste piping where heat tracing is installed.
1. Operating Temperature: 35 to 100 deg F.
 2. Insulation Material: Mineral fiber.
 3. Insulation Thickness: ½"
 4. Insert additional subparagraphs below if more size ranges are required. Select or insert pipe material to suit Project.
 5. Field-Applied Jacket: PVC.
 6. Vapor Retarder Required: No.
 7. Finish: None.
- F. Service: Condensate drain and auxiliary drain pan piping shall be insulated as specified for domestic chilled water or, if code approved, as follows.

1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: ½"
4. Field-Applied Jacket: None.
5. Vapor Retarder Required: Yes.
6. Finish: None.

G. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.

1. Operating Temperature: 35 to 120 deg F.
2. Insulation Material: Flexible elastomeric.
3. Field-Applied Jacket: PVC P-trap and supply covers.
4. Vapor Retarder Required: No.
5. Finish: Painted.

3.16 EXTERIOR INSULATION APPLICATION SCHEDULE

A. This application schedule is for aboveground insulation outside the building. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.

B. Service: Domestic water.

1. Operating Temperature: 60 to 140 deg F.
2. Insulation Material: Cellular glass, with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, all sizes: ½"
4. Field-Applied Jacket: Aluminum.
5. Vapor Retarder Required: Yes.
6. Finish: None.

C. Service: Storm water.

1. Operating Temperature: 32 to 100 deg F.
2. Insulation Material: Cellular glass, with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Cast Iron Pipe, all sizes: ½".
4. Field-Applied Jacket: Aluminum.
5. Vapor Retarder Required: Yes.
6. Finish: None.

END OF SECTION 220700

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

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 commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Commissioning Team: Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- B. Perform commissioning tests at the direction of the CxA.
- C. Attend construction phase controls coordination meeting.
- D. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.

- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction prefunctional checklists and commissioning process test procedures for actual Plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning functional testing.
- C. Provide test data, inspection reports, and certificates in Systems Manual.
- D. Provide test data, inspection reports, and certificates in Systems Manual.
- E. Coordinate training with Project Team for Facility Partner Mobile Engineer on installed MEP systems

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists for plumbing systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prefunctional checklists, and functional testing checklists are completed.
 - 5. Test and inspection reports and certificates.
 - 6. Corrective action documents.

1.7 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.
- C. Prefunctional Checklists.
 - 1. Complete and submit electronic copies of prefunctional checklists provided in Appendix A to Cx Authority
 - 2. .

1.8 ACCEPTANCE CRITERIA

- A. All specified valves and plumbing fixtures, including but not limited to trap primers, water hammer arresters, back flow preventers, pressure reducing valves, shut off valves, and pressure gauges, shall be installed without leaks per manufacturer recommendations and applicable standards and codes.
- B. Water meter shall be installed with correct flow direction and without leaks.
- C. All piping shall be installed without dents, leaks, shall have the specified insulation, and shall be properly supported.
- D. All piping shall be properly identified by stenciling or labeling.
- E. Tank Water Heater shall be installed and in good operating conditions without dents or leaks.
- F. Expansion tanks, unions, heat traps, and pressure relief valves shall be installed per plans, specifications, and applicable codes and standards.
- G. Integral water heater thermostat shall be set at 110 °F, plus or minus 5°F.
- H. Hot water shall be delivered promptly to all associated faucets a temperature acceptable to the Authority Having Jurisdiction.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide test equipment as necessary for start-up and testing of mechanical equipment. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the following tolerances:
 - 1. Temperature sensors and digital thermometers shall have an accuracy of 0.9°F and a resolution of +/- 0.1°F. Sensors and thermometers shall have been calibrated within the last year.
 - 2. Equipment shall be calibrated according to the manufacturer's recommended interval, within the last year, or when dropped or damaged, whichever is more recent. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Attend a pre-construction commissioning meeting where the commissioning process and schedule will be reviewed. Meeting may take place via telephone.

- B. Attend a mid-construction commissioning meeting. Provide a copy of the prefunctional checklists in Appendix A showing the construction progress.
- C. Attend a functional test pre-action meeting. This meeting shall occur after the prefunctional checklists are completed and submitted to the Commissioning Authority. Ensure that the individual who attends this meeting has the authority to schedule personnel who will be completing the functional tests.
- D. Participate in functional test day. Ensure that each scheduled individual is on site at designated scheduled time to perform functional tests as outlined in the commissioning process and pre-functional checklists.
- E. Participate in MEP training. Ensure the Facility Partner Mobile Engineers have sufficient knowledge of operating and adjusting all equipment.

3.2 SCHEDULING

- A. Functional testing shall begin after Prefunctional Checklists are completed, submitted to the Owner, and approved.

3.3 PARTICIPATION IN COMMISSIONING

- A. Designate Contractor team members to participate in the Prefunctional Checklists and the Functional Tests specified herein. The team members shall be as follows:
 - 1. Contractor's Plumbing Representative
 - 2. Contractor's Electrical Representative
 - 3. Owner's Project Manager
 - 4. Owner's Commissioning Authority
- B. Prefunctional Checklists and Functional Tests shall be completed by the commissioning team under direct guidance of the Commissioning Authority. Acceptance by each commissioning team member of each Prefunctional Checklist shall be indicated by signature and date. Acceptance by each commissioning team member of each functional test shall be indicated by signature and date.

3.4 TESTING PREPARATION

- A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Set systems and equipment into operating mode to be.
- C. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.5 GENERAL TESTING REQUIREMENTS

- A. The Contractor shall provide all materials, services, and labor required to perform the prefunctional checks and functional tests at the direction of the CxA.
- B. Scope of plumbing testing shall include all domestic water plumbing installation, Testing shall include measuring capacities and operation of equipment
- C. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- D.

3.6 TESTING PROCEDURES

- A. Pre-Functional Checklists shall be performed for the items indicated in Appendix A. Deficiencies discovered during these checks shall be corrected and re-inspected in accordance with the applicable contract requirements.
- B. Functional Tests shall be performed to demonstrate compliance with the Acceptance Criteria listed in this section. Functional Tests shall begin only after all Prefunctional Checklists have been successfully completed and the Functional Test pre-action meeting is conducted. Tests shall prove modes of the sequences of operation, and shall verify other relevant contract requirements.

3.7 WORK TO RESOLVE DEFFICIENCIES

- A. Upon failure of any Functional Test item, the Contractor shall correct deficiencies in accordance with the applicable contract requirements. The item shall then be retested until it has been completed with no errors.
- B. In some systems, deficient performance will result in additional work being required to commission systems. Complete Work under direction of the Owner with input from the CxA.
- C. Whereas all members will have input and opportunity to discuss the Work and resolve problems, the Owner will have final authority on necessary work to be done to achieve performance.
 - 1. Complete corrective work to permit completion of commissioning process.
 - 2. Experimentation to achieve system performance is permitted. If the Commissioning Authority deems experimentation work to be ineffective or untimely as it relates to commissioning process, Commissioning Authority will notify the Owner indicating nature of problem, expected steps to be taken, and deadline for completion of activities.
 - 3. If deadlines pass without resolution of the problems, the Owner reserves right to obtain supplementary services and equipment to resolve problems. Costs incurred to solve problems in an expeditious manner will be the Contractor's responsibility.

3.8 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, and similar activities are completed. The Contractor, suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

END OF SECTION 23 08 00

SECTION 221116 – DOMESTIC WATER PIPING

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 domestic water piping from locations indicated to fixtures and equipment inside the building.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
 - 2. Division 23 Section "Plumbing Specialties" for water distribution piping specialties.

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. PA: Polyamide (nylon) plastic.
- C. PE: Polyethylene plastic.
- D. PEX: Crosslinked polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Service Piping: 160 psig
 - 2. Domestic Water Distribution Piping: 125 psig

SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in "Cleaning" Article in Part 3.

- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- C. Transition Couplings for Underground Pressure Piping: Metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- D. Domestic water piping, 4" and smaller in size, and within the building and underground, shall be American manufactured Type "K" commercially pure copper water tubing. The use of joints in the piping beneath concrete slabs will be avoided and will be permitted only to the extent of long runs where a single roll of soft-annealed copper tubing or length of hard drawn copper tubing is not of sufficient length to complete the piping run. Should a joint be required, the joint shall be made with 95-5 tin-antimony solder and wrought solder joint copper fittings.
- E. Domestic water piping, 4" and smaller in size, and within the building and above ground, shall be American manufactured Type "L" hard drawn commercially pure copper pipe. Piping shall be assembled with wrought copper joint fittings or Victaulic "No Sweat" couplings. Solder flux shall be a non -corrosive paste type. Cored solder will not be allowed; all solder shall be solid string or wire type. Where soldered copper piping must be connected to screwed brass pipe, a cast brass adapter shall be used. Piping shall be assembled with 95-5 tin/antimony solder.
- F. Water piping connections to fixtures or equipment shall be made by the use of brass pipe or nipples, chrome plated where exposed to view in finished areas, screwed into copper-to-IPS adapter fittings. Ferrous piping connections will not be used in copper piping systems.
- G. Dielectric insulating couplings, unions, flanges or Victaulic Style 47 clearflow fitting shall be provided between ferrous and copper piping systems.

2.2 VALVES

- A. Refer to Division 22 Section "Valves" for bronze and cast-iron, general-duty valves.
- B. Refer to Division 22 Section "Plumbing Specialties" for balancing and drain valves.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- 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 may be used on aboveground piping, unless otherwise indicated.
- C. Grooved joints may be used on aboveground grooved-end piping.
- D. Fitting Option: Mechanically formed tee-branch outlets and brazed joints may be used on aboveground copper tubing.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball or gate valves for piping **NPS 2** and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping **NPS 2-1/2** and larger.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping **NPS 2** and smaller. Use cast-iron butterfly valves with flanged ends for piping **NPS 2-1/2** and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Cast-iron, grooved-end valves may be used with grooved-end piping.

3.4 PIPING INSTALLATION

- A. Refer to Division 2 Section "Water Distribution" for site water distribution and service piping.
- B. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping installation.
- C. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.

- D. Install underground ductile-iron piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 1. Encase piping with polyethylene film.
- E. Install underground copper tubing according to CDA's "Copper Tube Handbook."
- F. 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. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.
- G. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for wall penetration systems.
- H. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each domestic water service. Refer to Division 22 Section "Plumbing Meters and Gages" for pressure gages, and to Division 22 Section "Plumbing Specialties" for drain valves and strainers.
- I. Install water-pressure regulators downstream from shutoff valves. Refer to Division 22 Section "Plumbing Specialties" for water-pressure regulators.
- J. Install aboveground domestic water piping level and plumb.
- K. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- L. Perform the following steps 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 plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 6. Remove filter cartridges from housings, and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.
- M. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- N. Check plumbing specialties and verify proper settings, adjustments, and operation.
 - 1. Water-Pressure Regulators: Set outlet pressure at **80 psig** maximum, unless otherwise indicated.
- O. Energize pumps and verify proper operation.

3.5 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.
- B. Soldered Joints: Use water-flushable, lead-free flux and lead-free-alloy solder.
- C. Grooved Joints: Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.6 VALVE INSTALLATION

- A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment. Use ball or gate valves for piping **NPS 2** and smaller. Use butterfly or gate valves for piping **NPS 2-1/2** and larger.
- B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops. Use ball or gate valves for piping **NPS 2** and smaller. Use butterfly or gate valves for piping **NPS 2-1/2** and larger.
- C. Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.
 - 2. Install stop-and-waste drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping **NPS 2** and smaller and butterfly valves for piping **NPS 2-1/2** and larger. Refer to Division 23 Section "Plumbing Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Refer to Division 23 Section "Plumbing Specialties" for calibrated balancing valves.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 23 Section "Mechanical Vibration Controls and Seismic Restraints" for seismic-restraint devices.
- B. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices.
- C. Install supports according to Division 22 Section "Hangers and Supports."
- D. Support vertical piping and tubing at base and at each floor.
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. **NPS 1-1/4** and Smaller: **84 inches** with **3/8-inch** rod.

2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.

F. Install supports for vertical steel piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

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.
- D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the following:
 1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 2. Plumbing Fixtures: Cold and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 3. Equipment: Cold and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 2. 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:
 - 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 for final inspection by 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 test or inspection, make required corrections and arrange for re-inspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping 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 domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. 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.
 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.

3.10 ADJUSTING

- A. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
1. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 2. Adjust calibrated balancing valves to flows indicated.

3.11 CLEANING

- A. Clean and disinfect potable and non-potable domestic water piping as follows:
1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures as 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 in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 221116

SECTION 221119 – PLUMBING SPECIALTIES

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 plumbing specialties:
 - 1. Backflow preventers.
 - 2. Water regulators.
 - 3. Thermostatic water mixing valves.
 - 4. Drain valves.
 - 5. Miscellaneous piping specialties.
 - 6. Flashing materials.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages" for water meters, thermometers, and pressure gages.

1.3 DEFINITIONS

- A. The following are industry abbreviations for plastic piping materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PUR: Polyurethane plastic.
 - 4. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Piping: 125 psig.
 - 2. Sanitary Waste and Vent Piping: 10-foot head of water.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
 - 1. Backflow preventers and water regulators.
 - 2. Balancing valves, water filters, and strainers.
 - 3. Thermostatic water mixing valves and water tempering valves.
 - 4. Water hammer arresters, air vents, and trap seal primer valves and systems.
 - 5. Drain valves, hose bibbs, hydrants, and hose stations.
 - 6. Backwater valves, cleanouts, floor drains, open receptors, trench drains, and roof drains.
 - 7. Air-admittance valves, vent caps, vent terminals, and roof flashing assemblies.
 - 8. Sleeve penetration systems.
 - B. Shop Drawings: Diagram power, signal, and control wiring.
 - C. Field test reports.
 - D. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
 - 1. Backflow preventers and water regulators.
 - 2. Water filters.
 - 3. Thermostatic water mixing valves and water tempering valves.
 - 4. Trap seal primer valves and systems.
 - 5. Hose stations and hydrants.
- 1.6 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. Where applicable, show under-floor layout of filter/sterilizer unit floor stand, ductwork, and relationships between all adjacent mechanical, plumbing, electrical, cable trays, and raised-floor structure.
- 1.7 QUALITY ASSURANCE
- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
 - B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.
 - 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. NSF Compliance:
 - 1. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

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. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bibb and hydrant installed.

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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 BACKFLOW PREVENTERS

- A. Available Manufacturers:
- B. Manufacturers:
 - 1. Ames Co., Inc.
 - 2. Cla-Val Co.
 - 3. CMB Industries, Inc.; Febco Backflow Preventers.
 - 4. Conbraco Industries, Inc.
 - 5. Watts Industries, Inc.; Water Products Div.
 - 6. Zurn Industries, Inc.; Wilkins Div.
- C. General: ASSE standard, backflow preventers.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - 2. **NPS 2-1/2** and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
 - a. Interior Lining: FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.
 - 3. Interior Components: Corrosion-resistant materials.
 - 4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
 - 5. Strainer: On inlet.
- D. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

- E. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with non-removable and manual drain features and garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.
- F. Intermediate Atmospheric-Vent Backflow Preventers: Suitable for continuous pressure application. Include inlet screen and two independent check valves with intermediate atmospheric vent.
- G. Reduced-Pressure-Principle Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves or ball valves, as indicated, on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with air-gap fitting located between two positive-seating check valves.
 - 1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
- H. Double-Check Backflow Prevention Assemblies: Suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves.
 - 1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
- I. Antisiphon-Pressure-Type Vacuum Breakers: Suitable for continuous pressure application. Include shutoff valves, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.
 - 1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
- J. Hose-Connection Backflow Preventers: Suitable for at least 3-gpm flow and applications with up to 10-foot head of water back pressure. Include two check valves; intermediate atmospheric vent; and non-removable, garden-hose threads on outlet.
- K. Back-Siphonage Backflow Vacuum Breakers: Suitable for continuous pressure and backflow applications. Include shutoff valves, check valve, test cocks, and vacuum vent.

2.3 WATER REGULATORS

- A. Manufacturers:
 - 1. Cla-Val Co.
 - 2. Watts Industries, Inc.; Water Products Div.
 - 3. Zurn Industries, Inc.; Wilkins Div.
- B. General: Water regulators, rated for initial working pressure of 150 psig minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.
 - 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. General-Duty Service: Single-seated, direct operated, unless otherwise indicated.
 - 2. NPS 2-1/2 and Larger: Bronze or cast-iron body with flanged ends. Include FDA-approved, interior epoxy coating for regulators with cast-iron body.

- a. Type: Single-seated, direct operated.
 - b. Type: Pilot-operated, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve.
3. Interior Components: Corrosion-resistant materials.
 4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
 5. Provide with pressure gauge on inlet and outlet.

2.4 DRAIN VALVES

- A. Hose-End Drain Valves: NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.
 1. Inlet: Threaded or solder joint.
 2. Outlet: Short-threaded nipple with garden-hose threads and cap.
- B. Hose-End Drain Valve: Gate valve, Class 125, bronze body, with NPS 3/4 threaded or solder-joint inlet and garden-hose threads on outlet and cap. Hose bibbs are prohibited for this application.
- C. Stop-and-Waste Drain Valves: Ball valve, rated for 200-psig minimum CWP or Class 125, gate valve; Bronze body, with NPS 1/8 side drain outlet and cap.

2.5 MISCELLANEOUS PIPING SPECIALTIES:

- A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.
 1. Manufacturers:
 - a. Precision Plumbing, Inc.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Industries, Inc.; Specification Drainage Operation.
- B. Hose Bibbs: Bronze body with replaceable seat disc for compression-type faucets. Include NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solderjoint inlet, of design suitable for pressure of at least 125 psig; integral non-removable, drainable hose-connection vacuum breaker; and garden-hose threads on outlet.
 1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 2. Finish for Finished Rooms: Chrome or nickel plated.
 3. Operation for Equipment Rooms: Wheel handle or operating key.
 4. Operation for Finished Rooms: Operating key.
 5. Include operating key with each operating-key hose bibb.
 6. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.6 FLASHING MATERIALS

- A. Lead Sheet: Copper bearing, with the following minimum weights and thickness, unless otherwise indicated:
 - 1. Vent Pipe Flashing: 3-lb/sq. ft., 0.0469-inch thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" 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. Locate backflow preventers in same room as connected equipment or system unless otherwise indicated.
 - 2. 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.
 - 3. Do not install bypass piping around backflow preventers.
 - 4. Locate a minimum of 12 inches above floor and a maximum of 60 inches above floor.
- C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- D. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.
- E. Install 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. Adjust valve for proper flow.
- F. Install expansion joints on vertical risers, stacks, and conductors if indicated.
- G. 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.
- H. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- I. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

- J. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- K. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- L. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inchesr Less: Equivalent to 1 percent slope, but not less than 1/4-inchtotal 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 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 connected to sanitary building drain, unless otherwise indicated.
- M. Install interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
- N. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- O. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- P. Install reinforcement for wall-mounting and recessed-type plumbing specialties.
- Q. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 23 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.
- R. Install air vents at piping high points. Include ball, gate, or globe valve in inlet and drain piping from outlet to floor drain.
- S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- T. 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.
- C. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.
- E. Connect plumbing specialties and devices that require power according to Division 16 Sections.

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-lb/sq. ft. 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Set flashing on floors and roofs in solid coating of bituminous cement.
- C. Secure flashing into sleeve and specialty clamping ring or device.
- D. Install flashing for piping passing through roofs with counter-flashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."
- E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and their installation, including piping and electrical connections. Report results in writing.
 - 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. Remove malfunctioning units, replace with new units, and retest.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221119

SECTION 221122 – METERS AND GAGES

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 meters and gages for mechanical systems.
- B. Related Sections include the following:
 - 1. Mechanical equipment Sections that specify meters and gages as part of factory-fabricated equipment.
 - 2. Division 22 Section "Domestic Water Piping" for domestic water service meters inside the building.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.
- B. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.
- C. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.
- D. Maintenance Data: For meters and gages to include in maintenance manuals specified in Division 1. Include data for the following:
 - 1. Water meters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Liquid-in-Glass Thermometers:
 - a. Terice: H. O. Terice Co.
 - b. Weiss Instruments, Inc.
2. Direct-Mounting, Filled-System Dial Thermometers:
 - a. Terice: H. O. Terice Co.
 - b. Weiss Instruments, Inc.
3. Pressure Gages:
 - a. Terice: H. O. Terice Co.
 - b. Weiss Instruments, Inc.
4. Test Plugs:
 - a. Flow Design, Inc.
 - b. Terice: H. O. Terice Co.
 - c. Watts Industries, Inc.; Water Products Div.
5. Water Meters:
 - a. ABB Water Meters, Inc.
 - b. Badger Meter, Inc.; Industrial Div. (Milwaukee, WI).
 - c. Carlon Meter Co., Inc.
 - d. Grinnell Corp.; Mueller Co.; Hersey Products Div.
 - e. Hersey Measurement Co.
 - f. ISTECH Corp.
 - g. Lee Brass Co.; Hays Div.
 - h. Master Meter, Inc.
 - i. Schlumberger Industries, Inc.; Water Div.
 - j. Sensus Technologies, Inc.
 - k. Water Specialties Corp.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Description: Comply with Standards ASTM.
- B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.
- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Tube: Red or blue reading, organic-liquid filled with magnifying lens.
- E. Scale: Satin-faced non-reflective aluminum with permanently etched markings.
- F. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 DIRECT-MOUNTING, FILLED-SYSTEM DIAL THERMOMETERS

- A. Description: Vapor-actuated, universal-angle dial type.
- B. Case: Drawn steel or cast aluminum, with 4 1/2-inch diameter, glass lens.
- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Thermal Bulb: Copper with phosphor-bronze bourdon pressure tube.
- E. Movement: Brass, precision geared.
- F. Scale: Progressive, satin-faced non-reflective aluminum with permanently etched markings.
- G. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.5 SEPARABLE SOCKETS

- A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
 - 4. Insertion Length: To extend to one-third of diameter of pipe.
 - 5. Heat-Transfer Fluid: Oil or graphite.

2.6 THERMOMETER WELLS

- A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of **2 inches**, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
 - 4. Insertion Length: To extend to one-third of diameter of pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.
 - 6. Heat-Transfer Fluid: Oil or graphite.

2.7 PRESSURE GAGES

- A. Description: Comply with ASME Standards, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.
- B. Case: Drawn steel, brass, or aluminum with **4 1/2-inch** diameter, glass lens.
- C. Connector: Brass, **NPS 1/4**.
- D. Scale: White-coated aluminum with permanently etched markings.
- E. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
- F. Range: Comply with the following:
 - 1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.
 - 2. Fluids under Pressure: Two times the operating pressure.

2.8 PRESSURE-GAGE FITTINGS

- A. Valves: **NPS 1/4** brass or stainless-steel needle type.
- B. Syphons: **NPS 1/4** coil of brass tubing with threaded ends.
- C. Snubbers: **NPS 1/4** brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.9 TEST PLUGS

- A. Description: Nickel-plated, brass-body test plug in **NPS 1/4"** fitting.
- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: **500 psig** minimum.
- D. Core Inserts: Two self-sealing valves, suitable for inserting **1/8-inch** OD probe from dial-type thermometer or pressure gage.

- E. Core Material for Air and Water: **Minus 30 to plus 275 deg F**, ethylene-propylene-diene terpolymer rubber.
- F. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.
- G. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.
 - 1. Pressure Gage and Thermometer Ranges: Approximately two times the system's operating conditions.

2.10 WATER METERS

- A. Description: AWWA C700, displacement type, bronze case. Registers flow in **gallons** or **cubic feet** as required by utility.
- B. Remote Registration System: Utility's standard; direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install in the following locations:
 - 1. Inlet and outlet of each water heater.
- C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
 - 1. Install with socket extending to one-third of diameter of pipe.
 - 2. Fill sockets with oil or graphite and secure caps.
- D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.
 - 1. Install with stem extending to one-third of diameter of pipe.
 - 2. Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

- A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
- B. Install dry-type pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Building water-service entrance.
- C. Install liquid-filled-type pressure gages at suction and discharge of each pump.
- D. Install pressure-gage needle valve and snubber in piping to pressure gages.
- E. Install connections, tubing, and accessories between flow elements and meters as prescribed by manufacturer's written instructions.

3.4 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to AWWA M6 and utility's requirements.
 - 1. Install displacement-type water meters with shutoff valve on water meter inlet. Install valve on water meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
 - 1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.
- B. Make electrical connections to power supply and electrically operated meters and devices.
- C. Ground electrically operated meters.
 - 1. 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.
- D. Install electrical connections for power and devices.
- E. Electrical power, wiring, and connections are specified in Division 26 Sections.

3.6 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.

- B. Adjust faces of meters and gages to proper angle for best visibility.
- C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 221122

SECTION 221316 – SANITARY WASTE AND VENT PIPING

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 soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.3 DEFINITIONS

- A. The following are industry abbreviations for plastic and rubber piping materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. EPDM: Ethylene-propylene-diene terpolymer.
 - 3. NBR: Acrylonitrile-butadiene rubber.
 - 4. PE: Polyethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings: For drainage system, include plans, elevations, sections, and details.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Flexible Transition Couplings for Underground Nonpressure Piping: Provide elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

2.2 CAST-IRON SOIL PIPING

- A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service class.
 - 1. Gaskets: ASTM C 564, rubber.
- B. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301.
 - 1. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral, center pipe stop.
 - a. Heavy-Duty, Type 304, Stainless-Steel Couplings: Type 304, stainless-steel shield; stainless-steel bands; and sleeve.
 - 1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 3-inch wide shield with 4 bands.
 - 2) NPS 5 to NPS 10 (DN 125 to DN 250): 4-inch wide shield with 6 bands.
 - b. Heavy-Duty, FM-Approved Couplings: Type 304, stainless-steel housing; stainless-steel bands; and sleeve.
 - 1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 3-inch- wide housing with 2 bands.
 - 2) NPS 5 to NPS 10 (DN 125 to DN 250): 4-inch- wide housing with 2 bands.
 - c. Heavy-Duty, Cast-Iron Couplings: 2-piece, cast-iron housing; stainless-steel bolts and nuts; and sleeve.
 - d. Heavy-Duty, Type 301, Stainless-Steel Couplings: Type 301, stainless-steel shield; stainless-steel bands; and sleeve.
 - 1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 3-inch wide shield with 4 bands.
 - 2) NPS 5 to NPS 10 (DN 125 to DN 250): 4-inch wide shield with 6 bands.
 - e. Compact, Stainless-Steel Couplings: CISPI 310 with stainless-steel corrugated shield; stainless-steel bands; and sleeve.

- 1) NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 2-1/8-inch wide shield with 2 bands.
- 2) NPS 5 and NPS 6 (DN 125 and DN 150): 3-inch wide shield with 4 bands.

2.3 COPPER TUBING

- A. Copper DWV Tube: Provide drainage tube, drawn temper.
 1. Copper Drainage Fittings: Provide wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M water tube, drawn temper.
 1. Copper Pressure Fittings: Cast-copper-alloy or wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Bronze Flanges: Class 150, with solder-joint end.
 3. Copper Unions: Cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Aboveground, Soil, Waste, and Vent Piping: Use the following piping materials.
 1. Sanitary drainage lines (soil, waste and vent) shall be American manufactured cast iron soil pipe and fittings conforming to the latest issue of ASTM A-888 or CISPI 301. Piping shall be coated inside and out and shall be labeled with the C.I. mark of quality and permanence. Weight of the pipe shall be Class "SV" service weight. Joints shall conform to the manufacturer's installation instructions and local code requirements. Hubless coupling gaskets shall conform to the latest issue of ASTM C-564. Hubless couplings shall consist of a 300 series stainless steel shield clamp assembly and an elastomeric sealing sleeve conforming to CISPI 310.
- C. Underground, Soil, Waste, and Vent Piping: Use the following piping materials.
 1. Sanitary drainage lines (soil, waste and vent) shall be American manufactured hub and spigot cast iron soil pipe and fittings conforming to the latest issue of ASTM A-74. Piping shall be coated inside and out and shall be labeled with the C.I. mark of quality and permanence. Weight of pipe shall be Class "SV" service weight. Joints shall be assembled with compression gaskets similar to Tyler Pipe and Foundry's "Ty-Seal" in strict accordance with the manufacturer's recommendations and shall conform to the

requirements of ASTM C-564 or, at the Contractors option, shall be assembled with lead and oakum.

3.3 PIPING INSTALLATION

- A. Refer to Division 2 Section "Sanitary Sewerage" for Project-site sanitary sewer piping.
- B. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping installation.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Cleanouts shall be provided at each change in direction of the soil lines, at the end of each continuous waste line, at the foot of each riser within the building, and at 75'-0" intervals in long horizontal lines except as noted. The sizes of cleanouts shall be identical with the size of soil or waste lines in which they are placed, except that cleanouts larger than four inches (4") in diameter will not be required. Cleanouts must be placed in accessible locations and where they occur in pipe chases, said cleanouts shall be placed above the floors in such a manner that they will be accessible through doors or they shall be brought through wall and provided with flush covers. All cleanouts serving water closets and urinals shall be located above the fixture rim.
- 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. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for sleeves and mechanical sleeve seals.
- F. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for wall penetration systems.
- 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.
- I. 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.
- J. 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.

- K. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- L. Install engineered soil and waste drainage and vent piping systems in locations indicated and as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.
- B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. Soldered Joints: Use water-flushable, lead-free flux and lead-free-alloy solder.
- D. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 VALVE INSTALLATION

- A. Refer to Division 22 Section "Valves" for general-duty valves.
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
 - 1. Use gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
 - 2. Use gate valve for piping NPS 2-1/2 (DN 65) and larger.
- C. Check Valves: Install swing check valve, downstream from 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. Refer to Division 23 Section "Plumbing Specialties" for backwater valves.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 23 Section "Mechanical Vibration Controls and Seismic Restraints" for seismic-restraint devices.
- B. Refer to Division 22 Section "Plumbing Hangers and Supports" for pipe hanger and support devices. Install the following:
 1. Vertical Piping: Clamps.
 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: Adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: Adjustable roller hangers.
 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 "Plumbing Hangers and Supports."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches w with 3/8-inch rod.
 2. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
 4. NPS 6 (DN 150): 60 inches with 3/4-inch rod.
 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4 (DN 32): 84 inches with 3/8-inch rod.
 2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
 3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
 4. NPS 2-1/2 (DN 65): 11 feet with 1/2-inch rod.
 5. NPS 3 (DN 80): 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.

7. NPS 6 (DN 150): 12 feet with 3/4-inch rod.

I. Install supports for vertical steel piping every 15 feet..

J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
3. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch rod.
5. NPS 6 (DN 150): 10 feet with 5/8-inch rod.

K. Install supports for vertical copper tubing every 10 feet.

3.7 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. Refer to Division 23 Section "Plumbing Fixtures."
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. Refer to Division 23 Section "Plumbing Specialties."
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 (DN 65) and larger.

3.8 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 re-inspection.

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 (30 kPa). 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 (250 Pa). 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.

3.9 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 221316

SECTION 22 33 00 - ELECTRIC DOMESTIC WATER HEATERS

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 the following electric water heaters:
 - 1. Commercial, storage electric water heaters.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. LEED Submittal:
 - 1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2010, Section 7 - "Service Water Heating."
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Manufacturer Seismic Qualification Certification (If project in Seismic zone): 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."
 - 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.

1.4 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.
- 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. ASHRAE/IESNA 90.1-2010 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010.
- E. 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.
- F. 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.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMMERCIAL ELECTRIC WATER HEATERS

- A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Available Manufacturers:
 - a. American Water Heater Company.
 - b. Bock Water Heaters, Inc.
 - c. Bradford White Corporation.
 - d. Cemline Corporation.
 - e. Electric Heater Company (The); Hubbell Heaters Division.
 - f. GSW Water Heating Company.
 - g. HESco Industries, Inc.
 - h. Lochinvar Corporation.
 - i. Precision Boilers.
 - j. PVI Industries, LLC.
 - k. RECO USA.
 - l. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - m. Ruud Water Heater Div.; Rheem Manufacturing Company.
 - n. Smith, A. O. Water Products Company.
 - o. State Industries, Inc.
 - p. Vaughn Manufacturing Corporation.
2. Storage-Tank Construction: ASME-code, steel vertical arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 (DN 65) 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.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: 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 arranged in multiples of three.
 - 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. Special Requirements: NSF 5 construction.

5. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
6. Capacity and Characteristics:
 - a. Provide as scheduled or approved equivalent.

2.3 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

1. Available Manufacturers:
 - a. AMTROL Inc.
 - b. Armstrong Pumps, Inc.
 - c. Flexcon Industries.
 - d. Honeywell Sparco.
 - e. Myers, F. E.; Pentair Pump Group (The).
 - f. Smith, A. O.; Aqua-Air Div.
 - g. State Industries, Inc.
 - h. Taco, Inc.
 - i. Watts Regulator Co.
 - j. Wessels Co.
2. Construction:
 - a. Tappings: 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:
 - a. Working-Pressure Rating: 150 psig.
 - b. Capacity Acceptable: 2 gal. minimum.
 - c. Air Precharge Pressure: 55 psig minimum.

2.4 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. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
- C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

- D. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2010.
- E. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig-maximum outlet pressure, unless otherwise indicated.
- F. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.
- G. Leak Detector Shut Off Valve; resettable, testable protection device with sensor located in drain pan.

2.5 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 commercial water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
- 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 storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-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 combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-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.
- F. Install water-heater 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 water heaters that do not have tank drains.

- G. Install thermometer on outlet piping of water heaters.
- 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.

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. 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.
- B. 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.

END OF SECTION 22 33 00

SECTION 224000 – PLUMBING FIXTURES

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 plumbing fixtures and related components.
- B. Related Sections include the following:
 - 1. Division 22 Section "Emergency Plumbing Fixtures."
 - 2. Division 22 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of 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.

1.4 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.5 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 "Americans with Disabilities Act" and Texas Accessibility Standards about 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.

1.6 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

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. Revise subparagraphs below to suit Project.
 2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 3. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 4. Faucet, Laminar-Flow Fittings: Equal to 10 percent of amount of each type and size installed, but not less than 2 of each type and size.
 5. Faucet, Flow-Control Fittings: Equal to 10 percent of amount of each type and size installed.
 6. Supply, Flow-Control Fittings: Equal to 5 percent of amount of each type and size installed.
 7. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but not less than 12 of each type.
 8. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
 9. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. All plumbing fixtures shall be new, first quality, free from mars or chips and shall be furnished with sufficient support in order to adequately hang each and every unit. Fixtures shall be standard products as manufactured by American Standard, Kohler, or Eljer. The space between fixtures and walls shall be grouted with pure white Portland cement grout.
- B. Each and every unit shall be complete with all required trim and all exposed piping and trim shall be polished chromium plated, all brass. Flush valves for water closets and urinals shall be standard products as manufactured by Sloan, and shall be equal to Sloan "Royal". Refer to Section "Cleaning and Testing" within Division 23 for additional requirements related flush valves. Drains and Carriers shall be standard products as manufactured by Josam, Wade, J.R. Smith, Watts Drainage or Zurn.
- C. Plumbing fixtures shall be furnished as shown on the drawings.

PART 3 - EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
 - 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-hanging 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-hanging 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 manufacturers' written instructions and 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, gate, or globe valve if stops are not specified with fixture. Refer to Division 23 Section "Valves" for general-duty valves.
- 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 toilet seats on water closets.
- N. 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.
- O. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. 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.
- Q. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- R. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- S. 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. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for escutcheons.
- T. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 Section "Joint Sealants" for sealant and installation requirements.

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 water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed 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.

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, shower valves, and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

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.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 230500 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. It is the intent of the Contract Documents to provide an installation complete on every respect. In the event that additional details or special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as provide material and equipment usually provided with such systems or required to complete the installation.
- B. In case of conflict within the Specifications involving quality of material or procedure, Contractor shall furnish the higher quality material and procedure
- C. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Concrete base construction requirements.
 - 3. Escutcheons.
 - 4. Dielectric fittings.
 - 5. Flexible connectors.
 - 6. Mechanical sleeve seals.
 - 7. Equipment nameplate data requirements.
 - 8. Labeling and identifying mechanical systems and equipment is specified in Division 230553 Section "Mechanical Identification."
 - 9. Nonshrink grout for equipment installations.
 - 10. Field-fabricated metal and wood equipment supports.
 - 11. Installation requirements common to equipment specification sections.
 - 12. Mechanical demolition.
 - 13. Cutting and patching.
 - 14. Touchup painting and finishing.
- D. Pipe and pipe fitting materials are specified in Division 23 piping system Sections.

1.3 CODES, FEES, PERMITS, STANDARDS AND INSPECTIONS:

- A. All work performed under these Specifications shall be in strict accordance with all applicable City, County, State and National Codes, Specifications and Ordinances, and in accordance with all Utility Company regulations.

- B. Refer to Conditions of the Contract for payment of fees and permits.
- C. All materials and workmanship shall comply with all applicable state and national codes, specifications, and specified industry standards.
- D. The drawings and these specifications are intended to comply with all the above mentioned rules and regulations, however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect in writing of said discrepancies and apply for an interpretation and, unless an interpretation is offered in writing by the Architect, the applicable rules and regulations shall be complied with as a part of the contract.
- E. In case of difference between building codes, specifications, state laws, industry standards and the Contract Documents, the most stringent shall govern.

1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, 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 duct shafts.
- 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. Furnish: Pay for and deliver to the jobsite.
- G. Install: Fix permanently in place; make all necessary connections as related to all trades involved, place in operation, and test.
- H. Replace: Remove and install.
- I. Relocate: Remove and install.
- J. Contractor: Contractor responsible for all trades under the specifications covered by this Division.
- K. Work: Labor and/or materials accruing in the provision of a system as defined by the drawings and these specifications.
- L. Store: Provide an environmentally controlled space to protect the stored equipment from damage prior to installation.

- M. Remove: De-energize, disconnect, and de-commission the designated equipment as related to the trades required to take the equipment out of service. This shall include transporting the equipment to an off-site location as required by authorities having jurisdiction and regulatory agencies, unless directed otherwise by the Architect.
- N. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. NP: Nylon plastic.
 - 4. PE: Polyethylene plastic.
 - 5. PVC: Polyvinyl chloride plastic.
- O. The following are industry abbreviations for rubber materials:
 - 1. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 2. EPDM: Ethylene propylene diene terpolymer rubber.

1.5 SUBMITTALS

- A. Product Data: Data in the form of product specifications in cut-sheets, product data sheets for components of the mechanical systems. Product Data shall be submitted for dielectric fittings, transition fittings, escutcheons, flexible connectors, mechanical sleeve seals, and identification materials and devices. Data sheets with multiple product data, the relevant product data shall be highlight and/or non relevant product data shall be crossed out to clearly indentify the product data submitted for review.
- B. Shop Drawings: Detail fabrication and installation drawings for mechanical materials and equipment. Include supports and anchorage for mechanical materials and equipment.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Coordination Drawings shall include the following:
 - 1. Access panel and door locations.
 - 2. Sheetmetal duct drawings including BOD elevations and structural restrictions.
 - 3. Duct access door locations.
 - 4. Piping/Ductwork handing and supporting details.
 - 5. Building automation control electrical diagrams including contractor developed sequence of operations.
 - 6. HVAC valve tag charts and diagrams.
 - 7. Plumbing valve tag charts, piping lay-outs and diagrams.
 - 8. Sprinkler piping shop drawings including pipe sizes, pipe elevations, routing and head locations.
- E. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Clearances for installing and maintaining insulation.
3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
4. Equipment and accessory service connections and support details.
5. Exterior wall and foundation penetrations.
6. Fire-rated wall and floor penetrations.
7. Sizes and location of required concrete pads and bases.
8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

- F. Deviations: The approval of Submittal Drawings by the Architect, or his Representative, shall not relieve the Contractor from responsibility for deviation from Drawings or the specifications unless he has called attention in writing to such deviations at the time of submission and has obtained written approval from the Architect, or his Representative, of such deviations. The Contractor at no extra cost to the Owner will make any proposed change necessary for compliance with the Contract Drawings and Project Specifications.
- G. LEED submittals: Provide manufacturer's documentation for compliance with LEED EQ for low-emitting materials.
- H. Samples: Of color, lettering style and other graphic representation required for each identification material and device.

1.6 QUALITY ASSURANCE

- A. Comply with the applicable ASME Standards for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Materials shall be new and of the quality specified. All materials shall be free from defects at the time of installation. Materials or equipment damaged in shipment or otherwise damaged shall NOT be repaired at the jobsite, but shall be replaced with new materials.
- C. Equipment installed shall have local representation; local factory authorized service, and a local stock of repair parts, within 100 miles of the Project site.
- D. Comply with requirements of authorities having jurisdiction.
- E. All work shall be performed in the best and most workmanlike manner by mechanics skilled in their respective trades and properly licensed.
- F. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate

Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.7 PRODUCT UNIFORMITY

- A. In order to insure an integrated mechanical system providing ease of maintenance, operation, and repair, similar types of equipment shall be provided by a single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8.
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

1.10 COORDINATION

- A. Contractor shall be responsible for detailing, coordinating and fitting his material and apparatus

into the building and shall carefully lay out his work at the site to conform to the structural conditions, to provide proper grading of lines, to avoid all obstructions and to conform to the details of the installation supplied by the manufacturer of the equipment to be installed, and thereby to provide an integrated satisfactory operating installation, furnishing all necessary pilot lines and control lines whether indicated on the drawings or not. At no additional cost to the Owner, make all changes or additions to materials and/or equipment necessary to accommodate structural and architectural conditions.

- B. The mechanical plans do not give exact details as to hanging methods of pipes, ducts, materials, etc. Contractor shall refer to the Architectural and Structural Drawings for exact details but without exception all hangers or channels installed under this division of these specifications and spanning between framing members shall be secured to the building structure.
- C. The drawings do not give exact details as to elevations of pipe lines nor do they show exact locations of pipe to scale. Piping elevations shall be handled by giving precedence to pipes which require a stated grade for proper operation. Sewer piping shall take precedence over water pipes in determination of elevations. In all cases, pipes requiring a stated grade for their proper operation shall have precedence over electrical conduit and ductwork. Before installation of piping systems, the Contractor shall refer to the Construction as it is then in progress and determine the exact required locations of these systems in conjunction with advice from the representative of the Architect and/or Owner. Devices necessary for installation and support of pipes, and equipment (such as sleeves, inserts, etc.) shall be located and installed as the construction progresses in order to allow completion of each phase of the work in the proper sequence. Drawings showing the extent and arrangement of the work of a particular trade shall be used together with drawings showing extent and arrangement of work of other trades to insure that the Contractor in laying out and installing his work shall do so in a manner such that the work of the several trades may progress in the most direct, workmanlike harmonious manner.
- D. Contractor shall be responsible for the proper location and size of slots, holes or openings in the building structure, and for the correct location of pipe sleeves. The drawings indicate the extent and general arrangement of the various systems, but if any departures from these drawings are deemed necessary by the Contractor, descriptions of these departures and a statement of the reasons therefor shall be submitted to the Architect as soon as practicable.
- E. In general, piping and ductwork in finished areas of the building shall be installed and concealed in chases, furrings, and above suspended ceilings, unless noted and directed otherwise. Should any conditions arise which would cause any piping or ductwork to be exposed in finished areas, it shall be immediately called to the Architect's attention and correction of the discrepancy shall be made in accordance with the Architect's decision. In unfinished spaces such as equipment rooms, all pipe and ductwork shall be installed as high as possible and shall be installed to a continuous grade and shall be square to the building and securely supported. Piping shall be grouped wherever it is feasible to do so.
- F. Equipment shall be installed in such a manner to make oiling devices and parts (such as filters, drives, bearings, etc.) requiring service and maintenance readily accessible.
- G. All pipe, duct, etc., shall be cut accurately to measurements established at the building and shall be installed without springing or forcing. All ducts and pipes exposed in machinery and equipment rooms shall be installed parallel to the building planes, except that the lines shall be sloped to obtain the proper pitch. Piping and ducts above furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed during construction

until the systems are completed with final connection.

- H. The construction details of the building are illustrated on the Architectural and Structural Drawings. For new construction, place all inserts to accommodate the ultimate installation of pipe hangers in the forms before concrete is poured and set sleeves in forms before construction. For existing construction, all required inserts shall be "drilled-in" and all openings required through concrete or masonry shall be "saw-cut" or "core drilled" with tools specifically designed for this purpose.
- I. The mechanical plans do not give exact details as to elevations of lines, exact locations, etc., and do not show all the offsets, control lines, pilot lines and other location details. Carefully lay out work at the site to conform to the Architectural and Structural conditions, to provide proper grading of lines, to avoid all obstructions, to conform to the details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide an integrated satisfactory operation installation.
- J. The Mechanical Drawings do not give exact locations of outlets, fixtures, equipment items, etc. The exact location of each item shall be determined by reference to the general plans and to all detail drawings, equipment drawings, roughing-in drawings, etc., by measurements at the building and in cooperation with other trades. Minor relocations necessitated by the conditions at the site or directed by the Owner shall be made without additional cost to the Owner.
- K. Contractor shall supply and set in place waterproof flashings where pipes and ducts pass through roofs. The final installation of the flashings shall be coordinated with Division 7 of these Specifications.
- L. Locations and elevations of the various utilities, included within the scope of the work, have been obtained from utility maps and/or other substantially reliable sources and are offered separate from the contract documents as a general guide only, without guarantee as to accuracy. The Contractor shall examine the site and shall verify to his own satisfaction the size, location and elevations of all utilities and shall adequately inform himself of their relation with the work before entering into a contract.
- M. Sequence, coordinate, and integrate installing mechanical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- N. Coordinate location of access panels and doors for mechanical items that are concealed by finished surfaces. Access doors and panels shall be as specified within the Project Manual.

1.11 EQUIPMENT CONNECTIONS:

- A. It is the intent of the Contract Documents that all systems and equipment being furnished under the air conditioning and/or plumbing sections of these specifications shall be provided with all necessary utility connections completed to allow safe and proper operation of said systems. Where it is necessary to make final connections to items of equipment specified under other sections of these Specifications, all such work shall be performed in a neat and workmanlike manner and all materials shall be of quality and finish normally used for such installation.

1.12 EXCAVATION AND BACKFILL:

- A. Provide all necessary excavation and BACKFILL for the installation of the plumbing, heating, air conditioning, and ventilating work in accordance with Division 2 of these Specifications.
- B. The Contractor shall be responsible for submitting a site specific trench safety system prepared by a registered professional engineer who meets OSHA standards and any additional state and local standards.
- C. Trenches for all underground piping shall be excavated to the required depths. The bottoms of the trenches shall be tamped hard and graded to secure maximum fall. Bell holes shall be excavated to assure the pipes resting for its entire length on solid ground. Should rock be encountered, it shall be excavated to a depth 6" below the bottom of the pipe and shall be backfilled to the proper grade with pea gravel thoroughly tamped. Pipe laid in trenches dug in fill shall be supported down to load bearing undisturbed soil. When the pipes have been inspected and approved by inspecting authorities, the trenches shall be backfilled. The trenches shall be carefully backfilled with select fill material or pea gravel to a depth of six (6) inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials if of earth, loam, sand or gravel, free of large clods and with rocks no larger than 1-1/2" in diameter. Backfill shall be installed in layers 12" deep, adequately tamped and wetted down or flushed before the second layer of earth is laid in place.
- D. Underground pipes and conduits shall be installed below the local frost-line depth but in no case shall the bury depth be less than 24 inches below finished grade.
- E. Obtain soil report from Owner and evaluate existing conditions, and make allowance to provide filled and compacted areas relating to Mechanical, Electrical and Fire Protection work.

1.13 FLAME SPREAD PROPERTIES OF MATERIALS:

- A. All materials and adhesives used for air conditioning filters, acoustical lining and insulation, etc. shall conform to NFPA and UL life and safety and flame spread properties of materials. The composite classifications shall not exceed 25 for a flame spread rating and 50 for a smoke developed rating for these classifications as listed for the basic materials, the finishes, adhesives, etc., specified for each system and shall be such when completely assembled.

1.14 FLOOR, CEILING AND WALL PLATES:

- A. In each finished space, furnish a chromium plated sectional escutcheon on each pipe, or hanger rod penetrating a wall, floor or ceiling. Escutcheons shall be sized to fit snugly to all lines and where the lines are insulated, the escutcheons shall fit snugly over the insulation. Where required, these plates shall be provided with set screws so that they fit snugly against the finished surface.

1.15 OPERATION PRIOR TO COMPLETION

- A. When any piece of equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so providing that he properly supervises the operation. Contractor

shall be responsible for the operation and all maintenance of all equipment, ductwork and piping systems during this period. Contractor shall install and maintain pre-filters and final filters as specified during construction operations and shall change filters to prevent excessive filter loading.

- B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, and properly adjust the operation of the equipment before final acceptance by the Owner. Immediately prior to owner move-in, all equipment, piping, ductwork and all other devices shall be cleaned, adjusted and commissioned by the Contractor.
- C. The warranty period shall not commence until such time as the equipment is operated for the beneficial use of the Owner. The warranty period shall begin upon completion of the work, demonstration of complete and operating systems, and Substantial Completion certified by the Architect of the entire Project for the Owner or until final acceptance by the Owner.

1.16 WARRANTY

- A. Project warranty shall be as specified in Division 1, General Requirements Section, but not less than one (1) year from final acceptance.

1.17 PROJECT RECORD DOCUMENTS AND RECORDS FOR OWNER

- A. Project record documentation and records for the Owner shall be as specified in Division 1, General Requirements Section.
- B. In addition to the Division 1 of these specification provide the following minimum items:
 - 1. Operations & Maintenance Manuals: Include, as appropriate to each item, sufficient information to provide for the Owner's operation and maintenance of equipment furnished.
 - 2. As-Built: Include neatly marked set of reproducible drawings showing "As Installed" work.
 - 3. Contacts: Include with each product, name, address, and telephone numbers, of installing contractor, factory and local service representative.
 - 4. Instructions of Owner's Personnel: Prior to final inspection and acceptance, fully instruct the Owner's designated operating and maintenance personnel in the operating and performance of the equipment furnished.
 - 5. Warranties: Include warranty information properly executed by respective manufacturers, suppliers, or sub-contractors for the equipment and system furnished.

1.18 SAFETY GUARDS

- A. Contractor shall furnish and install all safety guards required. All electrical equipment, belt driven equipment, projecting shafts and other rotating or energized parts shall be properly enclosed or adequately guarded.

1.19 SPACE AND EQUIPMENT ARRANGEMENT

- A. Size of equipment shown by the drawings is based on the dimensions of a particular manufac-

turer. Where other manufacturers are acceptable, it is the responsibility of the contractor to determine if the equipment he proposes to furnish will fit the space.

- B. Equipment shall be installed in a manner that will permit access to all surfaces requiring access. Proper clearances shall be maintained to meet all safety and operating requirements or codes and standards.

1.20 PROTECTION OF MATERIALS AND APPARATUS

- A. At all times take such precautions as may be necessary to properly protect the electrical apparatus from damage. This shall include the creation of all required temporary shelters and environmental control to adequately protect any electrical apparatus. Electrical apparatus shall be cribbed up from the floor and covered with protective coverings where necessary to protect the apparatus from damage.
- B. As required, 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 is not in a space that is continuously under normal control of temperature and humidity.
- C. Delivery, Storage, and Handling.
 - 1. Deliver pipes, tubes, and ductwork with factory or shop applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
 - 2. Protect stored pipes, tubes and ducts from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
 - 3. Protect flanges, fittings, and piping specialties from moisture and dirt.
 - 4. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- D. Damage resulting from failure to comply with this requirement will be considered justification for rejection of the damaged apparatus and requiring its complete replacement by the Contractor.

1.21 INSPECTION OF BUILDING SITE:

- A. Contractor shall visit the site, verifying all existing items indicated on plans and/or specified, and familiarize himself with the existing work conditions, hazards, grades, actual formations, soil, conditions, and local requirements. The submission of bids shall be deemed evidence of each visit. All Proposals shall take these existing conditions into consideration, and the lack of specific information on the drawings shall not relieve the Contractor of any responsibility.

1.22 ROOF PENETRATIONS:

- A. Roof openings shall be made in accordance with Division 7 of these Specifications.

1.23 ACCEPTABLE MANUFACTURERS

- A. Specifications and drawings are intended to indicate a minimum standard of quality for materials and equipment which is established by the listing of manufacturer's names and catalog numbers and/or the defining of the technical characteristics in detail or by referenced standards. Materials and equipment that do not comply with these standards of quality will NOT be considered.
- B. Contractor shall be responsible to identify any deviation of the submittal from the specified manufacturer, product, equipment or material. Approval by the Architect shall NOT be considered as acceptance of the deviation unless specifically identified and acknowledged by the Architect during the submittal process.
- C. Where only one manufacturer's name is listed in the equipment specification, other manufacturers of similar characteristics and of equal or better performance capacities may be considered for "or equal" approval by the Architect. Where more than one manufacturer is listed in the equipment specification, only those named manufacturers will be considered.
- D. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended, within the guarantee or warranty period, this material or equipment shall be replaced with the material or equipment specified at no cost to the Owner.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches on centers in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

2.2 SLEEVE

- A. Above grade and dry location sleeves shall be constructed from 20 gauge galvanized steel and shall be flush on both sides of wall surface penetrated. The sleeves shall be sized to allow free passage of the conduit to be inserted, and when this conduit is to be provided with firestopping, the sleeves shall be large enough to pass the conduit and install the necessary firestopping material. Floor sleeves shall extend two (2") inches above the finished floor slab elevation.
- B. Sleeves passing through walls or floors (except slab on grade) at or below finished grade eleva-

tion and/or in moist areas shall be constructed of galvanized steel, schedule 40 pipe, and shall be designed with suitable flange in the center of the floor or wall to form a waterproof passage. After the conduits have been installed in the sleeves, insure a waterproof penetration by the use of a "Link-Seal" by Thunderline or "Pipe-Linx" by Mason-Dallas, Inc. wall sleeve, or shall fabricate a sleeve in accordance with recommendation and sizing furnished by the Thunderline Corporation or Mason-Dallas, Incorporated.

- C. Sleeves passing through fire rated walls or floors shall be sealed with an approved fire-stop material, after installation of the conduit, such that the fire rating of the wall or floor is not degraded.

2.3 NON-PENETRATING ROOF SUPPORTS

- A. Support piping on roof with an engineered, prefabricated pipe support system designed for installation without roof penetrations, flashings, or damage to the roofing material. The system shall consist of bases, made of high density, polypropylene plastics with UV Protection, a hot dipped galvanized structural steel frame, and suitable pipe hangers for the application. Nuts, threaded rods and washers shall be hot dipped galvanized, spring nuts, and bolts for spring nuts, will be electro-plated. System shall be custom designed to fit piping and conduit to be installed, and the actual conditions of service.
- B. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69.

2.4 EQUIPMENT SUPPORT RAILS

- A. Equipment mounting supports fabricated from 18 gauge galvanized sheet steel structural members, unitized construction with integral base plate, continuous welded corner seams, a continuous pressure treated wood nailer and counter flashing.
- B. Provide high load-bearing capacity with internal bulkheads welded into position at specific intervals along the length of the rails.
- C. Provide nailer jackets welded to base section to restrain the wood nailer for installations with extreme uplift and twisting forces.

2.5 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Dielectric Unions:
 - a. Watts Industries, Inc.; Water Products Div.
 - b. Capitol Manufacturing Co.
 - c. Zurn Industries, Inc.; Wilkins Div.
 - 2. Dielectric Flanges:
 - a. Capitol Manufacturing Co.

- b. Central Plastics Co.
 - c. Watts Industries, Inc.; Water Products Div.
- 3. Dielectric-Flange Insulating Kits:
 - a. Calpico, Inc.
 - b. Central Plastics Co.
- 4. Dielectric Couplings:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- 5. Dielectric Nipples:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Perfection Corp.
 - c. Victaulic Co. of America.
- 6. Metal, Flexible Connectors:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Hyspan Precision Products, Inc.
 - c. Metraflex Co.
- 7. Mechanical Sleeve Seals:
 - a. Calpico, Inc.
 - b. Metraflex Co.
 - c. Thunderline/Link-Seal.

2.6 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: Pipe threads shall comply with the applicable ASME standards for factory-threaded pipe and pipe fittings.

2.7 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. Comply with the applicable ASME standards, 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 (for plumbing applications) Class 150

- (for hydronic applications), cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- 2. Comply with the applicable AWWA standards, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: Comply with the applicable ASME standards, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: Comply with the applicable ASTM standards.
 - 1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
 - 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
 - 3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
 - 4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
 - 5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- F. Brazing Filler Metals: Comply with the applicable AWS standards.
 - 1. BCuP Series: Copper-phosphorus alloys.
 - 2. BAg1: Silver alloy.
- G. Welding Filler Metals: Comply with applicable AWS standards for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements: Manufacturer's standard solvent cements for the following:
 - 1. ABS Piping: Comply with the applicable ASTM standards.
 - 2. CPVC Piping: Comply with the applicable ASTM standards
 - 3. PVC Piping: Comply with the applicable ASTM standards. Include primer according to ASTM standards.
 - 4. PVC to ABS Piping Transition: Comply with the applicable ASTM standards.
- I. Plastic Pipe Seals: Comply with the applicable ASTM standards, elastomeric gasket.
 - 1. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: Comply with the applicable AWWA standards, rubber gasket, carbon-steel bolts and nuts.

2.8 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300-psig minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Provide separate companion flanges and steel bolts and nuts for 150 or 300-psig minimum working pressure as required to suit system pressures.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- H. 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.

2.9 FLEXIBLE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2-Inch NPS and Smaller: Threaded.
 - 2. 2-1/2-Inch NPS and Larger: Flanged.
 - 3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.
- B. 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.
- C. 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.
- D. 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.
- E. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.10 MECHANICAL SLEEVE SEALS

- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

2.11 PIPING SPECIALTIES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
 2. Steel Pipe: Applicable ASTM standards, Type E, Grade A, Schedule 40, galvanized, plain ends.
 3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
 4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 5. Underdeck Clamp: Clamping ring with set screws.
- B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 2. OD: Completely cover opening.
 3. Cast Brass: One piece, with set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
 4. Cast Brass: Split casting, with concealed hinge and set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
 5. Stamped Steel: One piece, with set screw and chrome-plated finish.
 6. Stamped Steel: One piece, with spring clips and chrome-plated finish.
 7. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
 8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
 9. Stamped Steel: Split plate, with exposed-rivet hinge, set screw, and chrome-plated finish.
 10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
 11. Cast-Iron Floor Plate: One-piece casting.

2.12 GROUT

- A. Nonshrink, Nonmetallic Grout: Comply with the applicable ASTM standards.
1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psig, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: 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 Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturer's written instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
 - 2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- N. Install sleeves for pipes passing through concrete and masonry walls, 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. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Build sleeves into new walls and slabs as work progresses.
3. Install sleeves 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 6-inch NPS.
 - b. 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 7 for flashing.
 - c. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 7 for materials.
5. Use neutral-curing silicone sealant, unless otherwise indicated.
- O. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve 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** in diameter and larger.
 3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for **1-inch** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 7 for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- T. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
 4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 5. Threaded Joints: Thread pipe with tapered pipe threads according to the applicable ASME standards. 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:
 - a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - c. Align threads at point of assembly.
 - d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - e. 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.
 6. Welded Joints: Construct joints according to the applicable AWS standards, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
 7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
 8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
 - a. Comply with the applicable ASTM standards for safe-handling practice of cleaners, primers, and solvent cements.
 - b. ABS Piping: Comply with the applicable ASTM standards.
 - c. CPVC Piping: Comply with the applicable ASTM standards.
 - d. PVC Pressure Piping: Comply with the applicable ASTM standards.
 - e. PVC Nonpressure Piping: Comply with the applicable ASTM standards.
 - f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to the applicable ASTM standards.
 9. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to the applicable ASTM standards procedures and manufacturer's written instructions.
 - a. Plain-End Pipe and Fittings: Use butt fusion.
 - b. Plain-End Pipe and Socket Fittings: Use socket fusion.
- U. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.

2. Install flanges, in piping **2-1/2-inch NPS** and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
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.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. 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. Extend grease fittings to accessible locations.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.3 PAINTING AND FINISHING

- A. Refer to Division 9 for paint materials, surface preparation, and application of paint.
- B. Apply paint to exposed piping according to the following, unless otherwise indicated:
 1. Interior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 2. Interior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 3. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 4. Exterior, Ferrous Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 5. Exterior, Galvanized-Steel Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 6. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
- C. Do not paint piping specialties with factory-applied finish.
- D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and

procedures to match original factory finish.

3.4 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.5 FIRESTOPPING

- A. Apply fire-stopping or fireproofing materials to piping and ductwork penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Fire-stopping or fireproofing materials and installation requirements shall be as specified in the Project Manual.

3.6 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than **4 inches** larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates and applicable seismic codes for anchor bolt and tie locations. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS Standards, "Structural Welding Code--Steel."

3.8 OWNER FURNISHED EQUIPMENT

- A. Where the Owner has elected to procure some equipment for the project, it is the intent of these specifications that the Contractor shall accept responsibility of this equipment and provide the following:
 - 1. Coordinate shop drawing preparation.
 - 2. Provide supervision to coordinate shipping and accept delivery.
 - 3. Install and set in place.
 - 4. Provide power and control wiring to provide functions in accordance with these specifications.
 - 5. Deliver the equipment to the Owner in a workable, operating, and tested condition.
 - 6. Provide supervision to coordinate factory and on-site testing, start-up, and commissioning in accordance with these specifications.
 - 7. Provide supervision to coordinate Owner training and preparation of O&M Manuals.
- B. Coordinate list of equipment provided by Owner with Owner.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical 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.

3.10 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.11 GROUTING

- A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placing of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases to provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout according to manufacturer's written instructions.

3.12 FIELD QUALITY CONTROL

- A. Inspect installed components for damage or faulty work and repair or replace as necessary. The following minimum items shall be inspected:
 - 1. Ductwork
 - 2. Controls and wiring.
 - 3. Air Distribution Devices.
 - 4. Supporting devices for electrical components.
 - 5. Concrete bases.
 - 6. Electrical demolition.

7. Cutting and patching for mechanical construction.
8. Refinishing and touchup painting.
9. Fire-stopping and fireproofing material.
10. Safety guards.
11. Equipment identification.
12. Equipment Installation.

END OF SECTION 230500

SECTION 230513 - MOTORS

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 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.

1.3 SUBMITTALS

- A. Submittals: Provide motor submittals for each motor. Clearly indicate the Manufacturer's name, physical characteristics, electrical characteristics, application, full load efficiency, and any additional applicable information for review.

1.4 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.

PART 2 - PRODUCTS

2.1 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.

2.2 MOTOR CHARACTERISTICS

- A. Motors 3/4 hp and larger: Poly-phase motor.
- B. Motors smaller than 3/4 hp: Single-phase motor.
- C. Frequency and Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage and 60 Hz to which the motor is connected.
- D. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 4324 feet above sea level.
- E. 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.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium Energy efficient, as defined in NEMA MG 1-2016.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class B
- I. 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.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 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. 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.
 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 5. Inverter-Duty Motors shall be suitable for continuous operation from 25% to 125% of normal speed.
 6. Shaft Grounding Ring: Provide a circumferential shaft grounding ring with conductive micro fibers.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE AC INDUCTION MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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.

2.6 ELECTRONICAL COMMUTATED MOTORS

- A. Motor enclosures: Open type
- B. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications.
- C. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
- D. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.

- E. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
- F. Motor shall be a minimum of 85% efficient at all speeds.

PART 3 - EXECUTION

3.1 MOTOR INSTALLATION

- A. Comply with mounting and anchoring specification requirements in the project manual for mechanical vibration and seismic control.

3.2 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 2. Test interlocks and control features for proper operation.
 - 3. Verify that current in each phase is within nameplate rating.

3.3 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.4 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 230513

SECTION 230529 - HANGERS AND SUPPORTS

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 hangers and supports for mechanical system piping and equipment.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of the supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Shop Drawings: Include design calculations and indicate size and characteristics of components and fabrication details.
- C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze by a qualified professional engineer.
 - 1. 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 hangers and supports that are similar to those indicated for this Project in material, design, and extent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pipe Hangers:
 - a. AAA Technology and Specialties Co., Inc.
 - b. B-Line Systems, Inc.
 - c. Carpenter & Patterson, Inc.
 - d. Empire Tool & Manufacturing Co., Inc.
 - e. Globe Pipe Hanger Products, Inc.
 - f. Grinnell Corp.
 - g. GS Metals Corp.
 - h. Michigan Hanger Co., Inc.
 - i. National Pipe Hanger Corp.
 - j. PHD Manufacturing, Inc.
 - k. PHS Industries, Inc.
 - l. Piping Technology & Products, Inc.
 - 2. Channel Support Systems:
 - a. B-Line Systems, Inc.
 - b. Grinnell Corp.; Power-Strut Unit.
 - c. GS Metals Corp.
 - d. Michigan Hanger Co., Inc.; O-Strut Div.
 - e. National Pipe Hanger Corp.
 - f. Thomas & Betts Corp.
 - g. Unistrut Corp.
 - h. Wesanco, Inc.
 - 3. Thermal-Hanger Shield Inserts:

- a. Carpenter & Patterson, Inc.
 - b. Michigan Hanger Co., Inc.
 - c. PHS Industries, Inc.
 - d. Pipe Shields, Inc.
 - e. Rilco Manufacturing Co., Inc.
 - f. Value Engineered Products, Inc.
4. Powder-Actuated Fastener Systems:
- a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Masterset Fastening Systems, Inc.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Thermal-Hanger Shield Inserts: 100-psi minimum compressive-strength insulation, encased in sheet metal shield.
1. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.
 2. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
 4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
 5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.3 MISCELLANEOUS MATERIALS

- A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.
- C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 3. Design Mix: **5000-psi**, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.
- C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification 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 Two-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 pipe, **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 two 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.
- D. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification 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.
- E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification 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.
- F. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification 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 head room is limited.
- G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification 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 by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.
- H. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification 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.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
 1. Field assemble and install according to manufacturer's written instructions.
- C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
 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 D-1.1.
- D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
- E. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. 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.

- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- J. 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.
 - 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 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:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 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.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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.

3.5 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 Section "Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230548 - MECHANICAL VIBRATION CONTROLS

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 vibration isolators, vibration isolation bases and vibration isolation roof curbs.
- B. Related Sections include the following:
 - 1. Division 23 Section "Hangers and Supports" for pipe hanger restraints.
 - 2. Division 23 Section "Metal Ductwork" for flexible duct connectors.
 - 3. Division 23 piping Sections for flexible pipe connectors.

1.3 SUBMITTALS

- A. Product Data: Indicate types, styles, materials, and finishes for each type of isolator specified. Include load deflection curves.
- B. Shop Drawings: Show designs and calculations, certified by a professional engineer, for the following:
 - 1. Design Calculations: Calculations for selection of vibration isolators and design of vibration isolation bases.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the 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 vibration isolation bases that are similar to those indicated for this Project in material, design, and extent.

1.5 COORDINATION

- A. Coordinate layout and installation of vibration isolation and seismic-restraint devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of concrete housekeeping and vibration isolation bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Sections.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 115 mph.
 - 2. Wind Exposure Classification C
 - 3. Wind Importance Factor: 1.0
 - 4. Building Occupancy Classification Category: II
 - 5. Minimum 10 lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ThyCurb, Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. Mason Industries, Inc.
 - 4. Vibration Isolation Co., Inc.

2.3 VIBRATION ISOLATORS

- A. Isolator Pads (IP): Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.
 - 1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip pattern and steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
 - 2. Fiberglass or Cork Isolator Pads: Molded cork or glass fiber not less than 1 inch thick and pre-compressed through 10 compression cycles at 3 times the rated load.

3. Load Range: From 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.
- B. Rubber Isolator Mounts (RM): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top- and baseplates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range.
- C. Spring Isolators (SI): Freestanding, laterally stable, open-spring-type 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 1.2 times the 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 a 1/4-inch thick, rubber isolator pad attached to the baseplate underside. Size baseplates to limit floor loading to 100 psig.
 6. Top Plates: Provide threaded studs for fastening and leveling equipment.
 7. Finishes: Manufacturer's standard corrosive-resistant finish.
- D. Restrained Spring Isolators (RSI): Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.
1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled baseplate for bolting to structure and bonded to a 1/4-inch- thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.
 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. Lateral Stiffness: More than 0.8 times the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.
- E. Rubber Hangers (RH): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.
- F. Spring Hangers (SH): Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.
1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

2.4 VIBRATION ISOLATION ROOF CURBS (RVIRCR)

- A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 115-mph wind impinging laterally against the side of the equipment. Design restraints to meet seismic requirements of authorities having jurisdiction.
- B. Components: Upper support frame; lower support assembly; freestanding, un-housed, laterally stable steel springs; vertical and horizontal restraints.
 1. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer stripe for attachment of roof material and 2 inches of rigid insulation on the inside of the assembly.
 2. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 3. Water Seal: Elastomeric seal conforming to UL Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counterflashed over the roof materials.

2.5 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand wind forces.
- B. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces.
- C. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The 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. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable water-proof 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.
- 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and anchor vibration & sound control products according to manufacturer's written instructions and authorities having jurisdiction.
- B. Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.
- C. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required by authorities having jurisdiction.
- D. Install pipe connectors at connections for equipment supported on vibration isolators.

3.2 ADJUSTING AND CLEANING

- A. 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 operations.
- B. Adjust thrust restraints for a maximum of 1/4 inch of movement at start and stop.

3.3 HVAC VIBRATION CONTROL DEVICE SCHEDULE

	All areas except otherwise noted			
Equipment	Base	Flex	Isolator	Deflection (inches)
Fan Coil Units (Suspended)		Yes	SH	0.75
Fans:				
Inline/Cabinet		Yes	SH	0.75
Centrifugal - Indoor		Yes	SI	0.75
Utility Sets – Outdoor		Yes	SI	.75
Fan Powered Boxes		Yes	SH	0.75
Piping			SH	0.75

END OF SECTION 230548

SECTION 230553 - MECHANICAL IDENTIFICATION

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 mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Duct markers.
7. Valve tags.
8. Valve schedules.
9. Warning tags.

1.3 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. Valve numbering scheme.
- D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME Standards, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 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 location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data: Name and plan number.
 - 3. Size: **2-1/2 by 4 inches** for control devices and equipment.
- C. Equipment Signs: Comply with ASTM standards, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Data: Instructions for operation of equipment and for safety procedures.
 - 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
 - 3. Thickness: **1/8 inch**, unless otherwise indicated.
 - 4. Thickness: **1/16 inch** for units up to **20 sq. in.** or **8 inches** in length, and **1/8 inch** for larger units.
 - 5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- D. Access Panel and Door Markers: **1/16-inch-** thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide **1/8-inch** center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME Standards, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than **6 Inches**: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, **6 Inches** and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- C. Plastic Tape: Continuously printed, vinyl tape at least **3 mils** thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, **6 Inches** or Larger: **1-1/2 inches** minimum.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with **1/4-inch** letters for piping system abbreviation and **1/2-inch** numbers, with approved numbering scheme. Provide **5/32-inch** hole for fastener.
1. Material: 0.032-inch- thick brass.
 2. Valve-Tag Fasteners: Brass S-hook.

2.4 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: Comply with ASTM standards, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Fuel-burning units, including furnaces and heaters.
 - 2. Fans, blowers, primary balancing dampers, and mixing boxes.
 - 3. Packaged roof-top HVAC units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fire department hose valves and hose stations.
 - c. Meters, gages, thermometers, and similar units.
 - d. Furnaces and heaters.
 - e. Fans and blowers.
 - f. Packaged roof top units
 - g. Fan coil units.
 - h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.
- C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated-plastic equipment markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- D. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
 - 1. Identify mechanical equipment with equipment markers in the following color codes:
 - a. Green: For cooling equipment and components.
 - b. Yellow: For heating equipment and components.

- c. Orange: For combination cooling and heating equipment and components.
 - d. Brown: For energy-reclamation equipment and components.
 - 2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 4. Include signs for the following general categories of equipment:
 - a. Heaters.
 - b. Packaged roof-top units.
- E. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
- 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 - 2. Pipes with OD, Including Insulation, Less Than 6 Inches: Use color-coded, adjustable plastic bands at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

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; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
- 1. Valve Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. Fire Protection: 2 inches, round.
 - d. Gas: 1-1/2 inches, square.
 - 2. Valve Tag Color:

- a. Cold Water: Blue.
 - b. Hot Water: Natural.
 - c. Fire Protection: Red.
 - d. Gas: Green.
3. Letter Color:
- a. Cold Water: White.
 - b. Hot Water: Black.
 - c. Fire Protection: Black.
 - d. Gas: White.

3.5 VALVE SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

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 testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:
 - 1. Balancing airflow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
 - 2. Adjusting total HVAC systems to provide indicated quantities.
 - 3. Measuring electrical performance of HVAC equipment.
 - 4. Setting quantitative performance of HVAC equipment.
 - 5. Verifying that automatic control devices are functioning properly.
 - 6. Reporting results of the activities and procedures specified in this Section.
- B. Related Sections include the following:
 - 1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
 - 2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 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 design quantities.
- C. 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.
- D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- E. Report Forms: Test data sheets for recording test data in logical order.
- F. 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.

- G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- I. 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.
- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- K. Test: A procedure to determine quantitative performance of a system or equipment.
- L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- M. AABC: Associated Air Balance Council.
- N. AMCA: Air Movement and Control Association.
- O. CTI: Cooling Tower Institute.
- P. NEBB: National Environmental Balancing Bureau.
- Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.4 SUBMITTALS

- A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- B. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- C. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.
- D. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.
- E. LEED Submittals:
 - 1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 - 2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by AABC.
- B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 - 2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- C. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing."
- D. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards.
- E. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 COORDINATION

- 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 testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

- A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. National Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms stating that AABC will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of the 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.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine project record documents described in Division 1 Section "Project Record Documents."
- D. Examine Architect's and Engineer's 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 the 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 Specification 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 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 air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

- K. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine equipment for installation and for properly operating safety interlocks and controls.
- N. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices operate 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. Thermostats and/or remote space sensors are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 5. Sensors are located to sense only the intended conditions.
 - 6. Sequence of operation for control modes is according to the Contract Documents.
 - 7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - 8. Interlocked systems are operating.
 - 9. Changeover from heating to cooling mode occurs according to design values.
- O. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 6. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section.
- B. Cut insulation, ducts, 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 the insulation Specifications for this Project.

- C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

- 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. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections and functioning.
- I. Check for proper sealing of air-handling unit components.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

- A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems.
- B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 5. Adjust fan speed higher or lower than design with the approval of the Architect. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.
- C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.
- D. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.
- E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 - 8. Record final fan-performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Balance variable-air-volume systems the same as described for constant-volume air systems.
 - 2. Set terminal units and supply fan at full-airflow condition.
 - 3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 4. Readjust fan airflow for final maximum readings.

5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.
 7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering and leaving air temperatures.
- C. Record compressor data.

3.8 PROCEDURES FOR HEAT TRANSFER COILS

- A. Measure, adjust and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering and leaving air temperature at full load.
4. Voltage and ampere input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Electric-Heating Coils: Measure the following data for each coil:

1. Nameplate data.
2. Airflow.
3. Entering and leaving-air temperatures at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kW at full load.
6. Fuse or circuit-breaker rating for overload protection.

3.10 TEMPERATURE TESTING

- A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.11 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. Verify operation of limiting controllers (i.e., high and low-temperature controllers).
- E. Verify free travel and proper operation of control devices such as damper and valve operators.
- F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.
- G. Confirm interaction of electrically operated switch transducers.
- H. Confirm interaction of interlock and lockout systems.
- I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or non-grounded power supply.
- J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.12 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.13 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. 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. 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.

3.14 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of the instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to the certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.
- D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of testing, adjusting, and balancing Agent.
 - 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 testing, adjusting, and balancing Agent who certifies the report.
 - 10. Summary of contents, including the following:
 - a. Design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Nomenclature sheets for each item of equipment.
 - 12. Data for terminal units, including manufacturer, type size, and fittings.
 - 13. Notes to explain why certain final data in the body of reports vary from design values.
 - 14. Test conditions for fans and pump performance forms, including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings, including settings and percentage of maximum pitch diameter.
 - f. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Balancing stations.

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: Include the following:
 - 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: Include design and actual values for the following:
 - 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. Preheat coil static-pressure differential in **inches wg**
 - g. Cooling coil static-pressure differential in **inches wg**.
 - h. Heating coil static-pressure differential in **inches wg**.
 - i. Outside airflow in **cfm**
 - j. Return airflow in **cfm**.
 - k. Outside-air damper position.
 - l. Return-air damper position.

G. Apparatus-Coil Test Reports: For apparatus coils, include the following:

1. Coil Data: Include the following:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in **fins per inch**
 - 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: Include design and actual values for the following:
 - a. Airflow rate in cfm
 - b. Average face velocity in **fpm** 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. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in **psig**.
 - j. Refrigerant suction temperature in **deg F**.
- H. Gas Fired Heat Apparatus Test Reports: In addition to the manufacturer's factory startup equipment reports, include the following:
 - 1. Unit Data: Include the following:
 - 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: Include design and actual values for the following:
 - 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: Include the following:
 - 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: Include design and actual values for the following:
 - 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: Include the following:
 - 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: Include the following:
 - 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: Include design and actual values for the following:

- 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

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: Include the following:

- 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. Design airflow rate in cfm
- h. Design velocity in fpm
- i. Actual airflow rate in cfm
- j. Actual average velocity in fpm
- k. Barometric pressure in psig

Air-Terminal Device Reports:

1. Unit Data:

- a. System and rooftop unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number. Size.
- h. Effective area in sq.ft.
- i. Space temperature in deg F.

M. Compressor and Condenser Reports: 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: Include the following:

- a. Unit identification.
- b. Location.
- c. Unit make and model number.
- d. Manufacturer's compressor serial numbers.
- e. Compressor make.
- f. Compressor model and serial numbers.
- g. Refrigerant weight in lb
- h. Low ambient temperature cutoff in deg F

Test Data: Include design and actual values for the following:

- 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. Control settings.
- f. Unloader set points.
- g. Low-pressure-cutout set point in psig
- h. High-pressure-cutout set point in psig
- i. Suction pressure in psig
- j. Suction temperature in deg F
- k. Condenser refrigerant pressure in psig
- l. Condenser refrigerant temperature in deg F
- m. Oil pressure in psig
- n. Oil temperature in deg F
- o. Voltage at each connection.
- p. Amperage for each phase.
- q. The kW input.
- r. Crankcase heater kW.
- s. Number of fans.
- t. Condenser fan rpm.
- u. Condenser fan airflow rate in cfm
- v. Condenser fan motor make, frame size, rpm, and horsepower.
- w. Condenser fan motor voltage at each connection.
- x. Condenser fan motor amperage for each phase.

N. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.15 ADDITIONAL TESTS

- A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes semirigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
- B. Related Sections include the following:
 - 1. Division 7 Section for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Pipe Insulation" for insulation for piping systems.
 - 3. Division 23 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - b. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - c. Detail application of field-applied jackets.
 - d. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - a. Sheet Form Insulation Materials: 12 inches square.
 - b. Sheet Jacket Materials: 12 inches square.
 - c. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.
- E. Field quality-control reports.

F. LEED Submittals:

1. Product Data for Credit IEQ 2: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 2: For adhesives and sealants, documentation indicating that products 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."

G. Shop Drawings: Show fabrication and installation details for the following:

1. Removable insulation sections at access panels.
2. Application of field-applied jackets.
3. Applications at linkages for control devices.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to applicable ASTM standards, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors and Outdoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread rating of 75 or less and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate clearance requirements with duct Installer for insulation application.

1.7 SCHEDULING

- A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation 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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - b. Aeroflex USA, Inc.; Aerocel.
 - c. Armacell LLC; AP Armaflex.
 - d. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied FSK facing. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

- A. 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..

- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Use adhesive that complies 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," including 2004 Addenda.
- C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints..
 - a. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - a. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - b. Service Temperature Range: Minus 20 to plus 180 deg F.
 - c. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - d. Color: White.

2.4 SEALANTS

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - a. Width: 3 inches.
 - b. Thickness: 6.5 mils.
 - c. Adhesion: 90 ounces force/inch in width.
 - d. Elongation: 2 percent.
 - e. Tensile Strength: 40 lbf/inch in width.
 - f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - a. Width: 2 inches.
 - b. Thickness: 6 mils.
 - c. Adhesion: 64 ounces force/inch in width.
 - d. Elongation: 500 percent.
 - e. Tensile Strength: 18 lbf/inch in width.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

- a. Width: 2 inches.
- b. Thickness: 3.7 mils.
- c. Adhesion: 100 ounces force/inch in width.
- d. Elongation: 5 percent.
- e. Tensile Strength: 34 lbf/inch in width. Springs are used for large, 84-inch- (2130-mm-) diameter applications and on applications with rapid changes in expansion and contraction..

D. Insulation Pins and Hangers:

- a. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
- b. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
- c. 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.
- d. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
- e. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
- f. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- g. 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.
- h. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
- i. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
- j. Adhesive-backed base with a peel-off protective cover.
- k. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- l. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

E. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

F. Wire: 0.062-inch soft-annealed, stainless steel.

2.5 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

- 2.6 Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

2.7 FIELD-APPLIED JACKETS

- A. General: Company with applications ASTM Standards, for Type 1, unless otherwise indicated.
- B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil.
- C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC Jacket Color: White or as selected by the Architect.
- D. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with applicable ASTM Standards, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.
 - 1. Finish: Stucco Embossed finish.
 - 2. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and Kraft paper.
- E. Stainless-Steel Jacket: Deep corrugated sheets of stainless steel complying with application ASTM Standards for Type 304 or 316; 0.10 inch thick; and roll stock ready for shop or field cutting and forming to indicated sizes.
 - 1. Moisture Barrier: 1-mil thick, heat-bonded polyethylene and Kraft paper.
 - 2. Jacket Bands: Stainless steel, Type 304, 3/4 inch wide.
- F. All Weather Jacket: Composite membrane consisting of a multi-ply embossed UV-resistant aluminum foil/polymer laminate to which is applied a layer of rubberized asphalt equal to Polyguard Products, Inc Alumguard.
 - 1. The membranes are 'peel and stick', some are self-healing if punctured, UV stable, and will expand and contract with the mechanical system. All Alumaguard products are supplied in rolls for ease of application. All products are laminated to a disposable release sheet and require only a "peel 'n stick" application procedure.
 - 2. The membrane does not promote mold growth.

2.8 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Provide Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz. /sq. yd..

1. Tape Width: 4 inches.
- B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
 1. Stainless Steel: Applicable ASTM Standards, Type 304; 0.020 inch thick.
 2. Galvanized Steel: 0.005 inch thick.
- C. Wire: 0.062-inch, soft-annealed, stainless steel
- D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
 1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.
- E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
 1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.
- F. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

2.9 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
 - 3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
 - 1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.

2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.
- O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 1. Seal penetrations with vapor-retarder mastic.
 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 3. Seal insulation to roof flashing with vapor-retarder mastic.
- P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- Q. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.
- R. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.
 1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

- A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
 1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 4. Impale insulation over anchors and attach speed washers.
 5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
 8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
 10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.
- B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Space anchor pins as follows:
 - a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 - c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
 6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6 inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
 8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

- A. Apply insulation to ducts and plenums as follows:
1. Follow the manufacturer's written instructions for applying insulation.

2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.6 FIELD-APPLIED JACKET APPLICATION

- A. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- C. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- F. Where an all weather jacket are indicated, contractor shall verify and obtain the latest installation instructions from the manufacturer prior to any work being done. The board insulation should be mechanically installed on properly sealed duct according to the engineer's specification using insulation fasteners (mini-cup weld pins or perf. based pins and washers). The washers should be covered with a 4" square piece of smooth foil tape prior to jacketing the ductwork to prevent the puncture of the outer membrane by the fasteners. Insulation on the top of the ductwork should be installed in such a manner as to allow for 'water shed' from the top of the duct to prevent water from 'ponding'.

3.7 FINISHES

- A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.8 DUCT SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.
- B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.
- C. Insulate the following plenums and duct systems:
 - 1. Indoor concealed supply, return, and outside-air ductwork.
 - 2. Indoor exposed supply-, return-, and outside-air ductwork.
 - 3. Outdoor exposed supply and return ductwork.
- D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Testing agency labels and stamps.
 - 8. Nameplates and data plates.
 - 9. Access panels and doors in air-distribution systems.

3.9 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

- A. Service: Round and rectangular, supply, return and outside air ducts, concealed.
 - 1. Material: Mineral-fiber blanket.
 - 2. Thickness: 2 inches and 1.5-lb/cu. ft. nominal density.
 - 3. Number of Layers: One.
 - 4. Factory-Applied Jacket: Foil and paper.
 - 5. Vapor Retarder Required: Yes.
- B. Service: Round and rectangular, supply, return and outside air ducts, exposed.
 - 1. Material: Mineral-fiber board.

2. Thickness: 2 inches and 3-lb/cu. ft. nominal density.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

C. Service: Round and rectangular, and outside air ducts, concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 3 inches and 1.5-lb/cu. ft. nominal density.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

D. Service: Round and rectangular, outside air ducts, exposed.

1. Material: Mineral-fiber board.
2. Thickness: 3 inches and 3-lb/cu. ft. nominal density.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Vapor Retarder Required: Yes.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Round and rectangular, supply, return and outside air ducts, concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 3 inches and 1.5-lb/cu. ft. nominal density.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Field-Applied Jacket: Polyguard.
6. Vapor Retarder Required: Yes.

B. Service: Round and rectangular, supply, return and outside air ducts, exposed.

1. Material: Mineral-fiber board.
2. Thickness: 3 inches and 3-lb/cu. ft. nominal density.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Field-Applied Jacket: Polyguard.

- a. Installed a protective Aluminum, Stucco Embossed 0.024 inch thick jacket where the duct is subject to abuse.

6. Vapor Retarder Required: Yes.

C. Service: Round and rectangular, exhaust ducts, concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 1 inches and 1.5-lb/cu. ft. nominal density.
3. Number of Layers: One.

4. Factory-Applied Jacket: Foil and paper.
5. Field-Applied Jacket: Polyguard.
6. Vapor Retarder Required: Yes.

D. Service: Round and rectangular, exhaust ducts, exposed.

1. Material: Mineral-fiber board.
2. Thickness: 1 inches and 3-lb/cu. ft. nominal density.
3. Number of Layers: One.
4. Factory-Applied Jacket: Foil and paper.
5. Field-Applied Jacket: Polyguard.
 - a. Installed a protective Aluminum, Stucco Embossed 0.024 inch thick jacket where the duct is subject to abuse.
6. Vapor Retarder Required: Yes.

END OF SECTION 230700

SECTION 230719 - HVAC PIPING INSULATION

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 insulating the following HVAC piping systems:

- 1. Condensate drain piping.

- B. Related Sections:

- 1. Division 23 Section "HVAC Duct Insulation."
 - 2. Division 23 Section "HVAC Equipment Insulation".

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

- B. LEED Submittals:

- 1. Product Data for Credit IEQ 2: For adhesives and sealants, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for Credit IEQ 2: For adhesives and sealants, documentation indicating that products 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."

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- 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.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Sheet Form Insulation Materials: 12 inches square.
 - 3. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - 4. Sheet Jacket Materials: 12 inches square.
 - 5. 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.

1.4 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to 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 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 Mockups: Before installing insulation on all piping systems, insulate one representative component with the insulation and finish listed below to demonstrate quality of insulation application and finishes. Use materials indicated for the completed Work.

- 1. Pipe, fitting and valve:
 - a. One segment of piping.
 - b. One fitting.
 - c. Isolation and control valve.
- 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.

3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of the mockups before proceeding with insulating the remaining equipment.

1.6 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.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."
 1. Coordinate clearance requirements with piping Installer for piping 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.
- B. Coordinate installation and testing of heat tracing.

1.8 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 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation 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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells.
 - 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. Pittsburgh Corning Corporation; Foamglas.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of **minus 100 to plus 200 deg F**
 - 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies 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," including 2004 Addenda.

2.3 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White
 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, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - 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-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. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper
 - d. Moisture Barrier for Outdoor Applications: **3-mil-** thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-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 fabricated fitting covers only if factory-fabricated fitting covers are not available.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.>.
 2. Width: 3 inches.
 3. Thickness: **11.5 mils.**
 4. Adhesion: **90 ounces force/inch** in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: **40 lbf/inch** in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:

- a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.5 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following :
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with 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 closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

- #### A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- #### A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with **3-inch** wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced **4 inches** o.c.
 3. Overlap jacket longitudinal seams at least **1-1/2 inches**. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches 4 inches** o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least **4 inches** beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches** below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least **2 inches**.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches** o.c.
 - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two **0.062-inch**- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch** laps at longitudinal seams and **3-inch**- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with **2-inch** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands **12 inches** o.c. and at end joints.

3.10 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size..
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Materials and thicknesses in schedules below are for single-layer applications. If multilayer applications are needed, insert additional requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

- 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:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR AND PIPE CHASE PIPING INSULATION SCHEDULE

- A. Service: Refrigerant suction and hot-gas piping.
 - 1. Insulation Material: Flexible Elastomeric.
 - 2. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, all sizes: 1-1/2"
 - 3. Field-Applied Jacket: No.
 - 4. Vapor Retarder Required: No.
 - 5. Finish: None.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Service: Refrigerant suction and hot gas piping.
 - 1. Insulation Material: Flexible elastomeric.
 - 2. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Copper Pipe, all sizes: 1-½"
 - 3. Field-Applied Jacket: Aluminum.
 - 4. Vapor Retarder Required: No.
 - 5. Finish: 2 coats of U.V. protective coating.

3.15 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for outdoor installations.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Equipment, Exposed to potential abuse due contact such as foot traffic:
 - 1. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish 0.024 inch thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed and Exposed:
 - 1. Aluminum, Stucco Embossed: 0.020 inch.
- C. Equipment, Exposed to potential abuse due contact such as foot traffic:
 - 1. Stainless Steel, Type 304 Type 316, Stucco Embossed: 0.024 inch thick.

END OF SECTION 237019

SECTION 23 08 00 - COMMISSIONING OF HVAC

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 commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- B. Perform commissioning tests at the direction of the CxA.
- C. Attend construction phase controls coordination meeting.
- D. Attend testing, adjusting, and balancing review and coordination meeting.
- E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- F. Provide information requested by the CxA for final commissioning documentation.

- G. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction prefunctional checklists and commissioning functional test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning functional testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.
- E. Coordinate training with Project Team for Facility Partner Mobile Engineer on installed MEP systems

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Documents verifying completion of training with Facility Partner Mobile Engineers confirming required participation
 - 8. Corrective action documents.
 - 9. Verification of testing, adjusting, and balancing reports.

1.7 SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.
- C. Prefunctional Checklists.
 - 1. Complete and submit electronic copies of prefunctional checklists provided in Appendix A to Cx Authority

1.8 ACCEPTANCE CRITERIA

- A. Discharge air velocity at registers not to exceed 160 fpm
- B. Airflow at supply and return diffusers as well as outside air intake shall not exceed $\pm 10\%$ of design.
- C. Janitor's Closet exhaust fan shall run continuously.
- D. Filters processing outside or return air shall be minimum MERV 13.
- E. Air economizers will provide partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.
- F. When the RTU is in occupied mode, the supply air fans shall run continuously and minimum outdoor air shall be supplied unless economizer is in use.
- G. Outdoor air damper shall modulate to maintain a maximum of 1000 ppm in CO₂ levels as measured by CO₂ sensors when a sensor is indicated on the plans.
- H. RTU's shall have an internal optimize start/stop mode enabled.
- I. The Digital Interfaces will be adjustable to allow user to temporarily change set points for comfort control override of "Unoccupied" status. After HVAC control system has been overridden by a user, it shall reset to unoccupied status after 30 minutes.
- J. The time of day set on HVAC controllers shall be set within 2 minutes of each other.
- K. Control devices shall be labeled on the front or inside cover of the most visible surface.
- L. Ductwork shall be insulated per specification requirements.
- M. With the outdoor air conditions at 10% design dry bulb temperature and 10% wet bulb temperature, packaged units meet or exceed minimum manufacturer's heating and cooling efficiency.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide test equipment as necessary for start-up and testing of mechanical equipment. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the following tolerances:
 - 1. Temperature sensors and digital thermometers shall have an accuracy of 0.9°F and a resolution of $\pm 0.1^\circ\text{F}$. Sensors and thermometers shall have been calibrated within the last year.
 - 2. Pressure sensors shall have an accuracy of $\pm 2.0\%$ of the value range being measured (not full range of meter) and shall have been calibrated within the last year.

3. Equipment shall be calibrated according to the manufacturer's recommended interval, within the last year, or when dropped or damaged, whichever is more recent. Calibration tags shall be affixed or certificates readily available.
- B. Proprietary Test Equipment:
 1. For products in which proprietary test equipment is needed for a functional test, product manufacturer shall furnish test equipment, demonstrate its use, and assist Commissioning Authority in commissioning process. Proprietary test equipment shall become property of the Owner upon completion of commissioning

PART 3 - EXECUTION

3.1 MEETINGS

- A. Attend a pre-construction commissioning meeting where the commissioning process and schedule will be reviewed. Meeting may take place via telephone.
- B. Attend a mid-construction commissioning meeting. Provide a copy of the prefunctional checklists in Appendix A showing the construction progress.
- C. Attend a functional test pre-action meeting. This meeting shall occur after the prefunctional checklists are completed and submitted to the Commissioning Authority. Ensure that the individual who attends this meeting has the authority to schedule personnel who will be completing the functional tests.
- D. Participate in functional test day. Ensure that each scheduled individual is on site at designated scheduled time to perform functional tests as outlined in the commissioning process and pre-functional checklists.
- E. Participate in MEP training. Ensure the Facility Partner Mobile Engineers have sufficient knowledge of operating and adjusting all equipment

3.2 SCHEDULING

- A. Functional testing shall begin after Prefunctional Checklists are completed, submitted to the Commissioning Authority, and approved.

3.3 PARTICIPATION IN COMMISSIONING

- A. Designate Contractor team members to participate in the Prefunctional Checklists and the Functional Tests specified herein. The team members shall be as follows:
 1. Contractor's Electrical Representative
 2. Contractor's Mechanical Representative
 3. Owner's Project Manager
 4. Owner's Commissioning Authority
- B. Prefunctional Checklists and Functional Tests shall be completed by the commissioning team under direct guidance of the Commissioning Authority. Acceptance by each commissioning

team member of each Prefunctional Checklist shall be indicated by signature and date. Acceptance by each commissioning team member of each functional test shall be indicated by signature and date.

3.4 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.5 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 7 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Subcontractor 7 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.6 GENERAL TESTING REQUIREMENTS

- A. The Contractor shall provide all materials, services, and labor required to perform the prefunctional checks and functional tests at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Subcontractor, Testing and Balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.7 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. The prefunctional checklists and functional tests shall be performed in a manner that essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. A functional test shall be aborted if any

system deficiency prevents the successful completion of the test or if any participating commissioning team member of which participation is specified is not present for the test.

- B. Pre-Functional Checklists shall be completed for the items indicated in Appendix A. Deficiencies discovered during these checks shall be corrected and re-inspected in accordance with the applicable contract requirements.
- C. Functional Tests shall be performed to demonstrate compliance with the Acceptance Criteria listed in this section. Functional Tests shall begin only after all Prefunctional Checklists have been successfully completed and the Functional Test pre-action meeting is conducted. Tests shall prove modes of the sequences of operation, and shall verify other relevant contract requirements.

3.8 WORK TO RESOLVE DEFFICIENCIES

- A. Upon failure of any Functional Test item, the Contractor shall correct deficiencies in accordance with the applicable contract requirements. The item shall then be retested until it has been completed with no errors.
- B. In some systems, misadjustments, misapplied equipment, and deficient performance under varying loads will result in additional work being required to commission systems. Complete Work under direction of the Owner with input from the CxA.
- C. Whereas all members will have input and opportunity to discuss the Work and resolve problems, the Owner will have final authority on necessary work to be done to achieve performance.
 - 1. Complete corrective work to permit completion of commissioning process.
 - 2. Experimentation to achieve system performance is permitted. If the Commissioning Authority deems experimentation work to be ineffective or untimely as it relates to commissioning process, Commissioning Authority will notify the Owner indicating nature of problem, expected steps to be taken, and deadline for completion of activities.
 - 3. If deadlines pass without resolution of the problems, the Owner reserves right to obtain supplementary services and equipment to resolve problems. Costs incurred to solve problems in an expeditious manner will be the Contractor's responsibility.

3.9 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, and similar activities are completed. The Contractor, suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.

END OF SECTION 23 08 00

APPENDIX A PREFUNCTIONAL CHECKLISTS

1.1 SUMMARY

- A. This Appendix includes information regarding construction prefunctional checklists that will be used in implementation of the commissioning process.

1.2 RELATED SECTIONS

- A. Section 01810, "Commissioning Requirements" for a list of commissioned equipment and commissioning team responsibilities.

1.3 REQUIREMENTS

- A. Complete a construction prefunctional checklist for each item of equipment or other assembly specified to be commissioned.
- B. No sample of identical or near-identical items is allowed.
- C. Construction prefunctional checklists do not replace manufacturers' recommended startup checklists, regardless of apparent redundancy.

1.4 CONSTRUCTION PREFUNCTIONAL CHECKLISTS

- A. Prefunctional checklists for systems that must be commissioned to achieve a LEED green building certification have been included in this appendix. The following checklists are provided:
 - 1. Packaged Unit
 - 2. Air Distribution Equipment & Air Balance
 - 3. HVAC Controls
 - 4. Exhaust Fans

SECTION 232300 - REFRIGERANT PIPING

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 piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-22:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.
- B. 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.
- C. 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.
- D. 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.

1.4 REFRIGERANTS

- A. ASHRAE 34, R-22: Monochlorodifluoromethane.
- B. ASHRAE 34, R-134a: Tetrafluoroethane.
- C. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
- D. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4 inch equals 1 foot.
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to 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."

1.9 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.10 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: 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.
- 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. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 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. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. 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 ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with 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 Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 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: Adjustable.
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: External.
 7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-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 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 ARI 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.
 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 ARI 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.
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. Receivers: Comply with ARI 495.

1. Comply with 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.

O. Liquid Accumulators: Comply with ARI 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.

PART 3 - EXECUTION

3.1 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 solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- F. 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.
- G. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- H. 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.
- I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- J. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- K. Install flexible connectors at compressors.

3.2 PIPING INSTALLATION

- A. 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.
- B. Install refrigerant piping according to ASHRAE 15.
- 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 adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.

- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. 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 as specified in Division 23 "Basic Mechanical Materials and Methods" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. 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.
- O. 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.
- 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 23 "Identification for HVAC Piping and Equipment."
- R. Install sleeves and escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 "Basic Mechanical Materials and Methods".

3.3 PIPE 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. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Braze 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.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 "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. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Support multi-floor vertical runs at least at each floor.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. 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 Part 1 "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.

3.6 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.

3.7 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 232913 – MOTOR CONTROLLERS

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 alternating current motor-control devices rated 600 V and less that are supplied as enclosed units.

1.3 SUBMITTALS

- A. Product Data: For products specified in this Section. Include dimensions, ratings, and data on features and components.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain similar motor-control devices through one source from a single manufacturer.
- B. Standards: Comply with applicable NEMA, IEEE, UL and NFPA Standards.
- C. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled. The terms "Listed" and "Labeled" shall be as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

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. Allen-Bradley Co.; Industrial Control Group.
 - 3. Eaton Corp.; Westinghouse & Cutler-Hammer Products.
 - 4. Furnas Electric Co.
 - 5. General Electric Co.; Electrical Distribution & Control Div.
 - 6. Siemens Energy & Automation, Inc.
 - 7. Square D Co.

2.2 MANUAL MOTOR CONTROLLERS

- A. Controller shall be NEMA, general purpose, Class A with toggle action and overload element.

2.3 MAGNETIC MOTOR CONTROLLERS

- A. Description; Controller shall be NEMA, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
- B. Control Power; Obtain control circuit power from integral 120 volt control power transformer, unless otherwise indicated. Include a control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
- C. Combination Controller: Factory-assembled combination controller and overcurrent protection device as indicated.
 - 1. Fusible Disconnecting Means: NEMA, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses indicated.
 - 2. Circuit-Breaker Disconnect: NEMA, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.
- D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic. 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.
- E. Multispeed-Motor Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
 - 1. Compelling relay ensures motor will start only at low speed.
 - 2. Accelerating relay ensures properly timed acceleration through speeds lower than that selected.
 - 3. Decelerating relay ensures automatically timed deceleration through each speed.
- F. Star-Delta Controller: NEMA, closed transition with adjustable time delay.
- G. Part-Winding Controller: NEMA, closed transition with separate overload relays for starting and running sequences.
- H. Autotransformer Reduced-Voltage Controller: NEMA, closed transition.
- I. Solid-State, Reduced-Voltage Controller: NEMA, suitable for use with standard NEMA, Design B, polyphase, medium induction motors.
 - 1. Adjustable acceleration rate control uses voltage or current ramp, and adjustable starting torque control has up to 500 percent current limitation for 20 seconds.
 - 2. Surge suppressor in solid-state power circuits provides 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - 3. LED indicators show 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 operates automatically when full voltage is applied to motor.

2.4 ENCLOSURES FOR INDIVIDUALLY MOUNTED CONTROLLERS

- A. Description: Flush or surface-mounted cabinets as indicated. NEMA, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
 1. Outdoor Locations: NEMA, Type 3R.
 2. Kitchen Areas: NEMA, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA, Type 4.
 4. Hazardous Areas: NEMA Type suitable for the Division, Class, and Group of the hazardous environment.

2.5 ACCESSORIES

- A. General: The following devices shall be factory installed in controller enclosure as scheduled on the Drawings, unless otherwise indicated.
 1. Pilot Lights: NEMA, heavy-duty type with color indicating motor operating condition—red—running, green—off or not running, etc.
 2. Stop and Lockout Push-Button Station: Momentary-break push-button station with a factory-applied hasp arranged so a 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. Meters: Panel type, **2-1/2-inch** minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide transfer device with an off position. Meters indicate the following:
 - a. Ammeter: To indicate output current, with current sensors rated to suit application.
 - b. Voltmeter: To indicate output voltage.
 - c. Frequency Meter: To indicate output frequency.
 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: 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. Provide adjustable response delay.
 7. Push-Button Station: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.
 8. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of

- motors started and stopped by automatic controls or interlocks with other equipment.
9. Normally Open/Normally Closed Contacts: In manual and magnetic controllers where indicated or required for motor operation and control.
 10. Remote Push-Button Stations: In separate enclosures as indicated on the Drawings for remote manually started motors.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty-cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions. Coordinate the exact motor controller requirements with the equipment scheduled on the Drawings and with the actual equipment being supplied to the project.

3.2 INSTALLATION

- A. Install independently mounted motor-control devices according to manufacturer's written instructions.
- B. Locate controllers within sight of motors controlled, unless otherwise indicated.
- C. For control equipment mount on lightweight structural steel channels bolted to the walls or free-standing and adequately supported.
- D. Install freestanding equipment on minimum **4 inches** high concrete housekeeping bases conforming to Division 3 Section of these specifications.
- E. Install indicated fuses in each fusible switch.

3.3 CONTROLLER WIRING INSTALLATION

- A. Install wiring between motor-control devices according to other Division 23 and 26 Sections of these specifications.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic control devices where required and according to indicated wiring diagrams:
 1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
 2. Connect selector switches with motor-control 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.

3.4 CLEANING

- A. Inspect interior and exterior of motor controllers. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

END OF SECTION 232913

SECTION 233113 - METAL DUCTS

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 rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 1 to plus 6-inch wg.
- B. Related Sections include the following:
 - 1. Division 07 for fire-resistant sealants for use around duct penetrations and fire-damper installations in fire-rated floors, partitions, and walls.
 - 2. Division 08 for wall and ceiling-mounted access doors for access to concealed ducts.
 - 3. Division 10 For intake and relief louvers and vents connected to ducts and installed in exterior walls.
 - 4. Division 23 for duct insulation.
 - 5. Division 23 for dampers, sound-control devices, duct-mounted access doors and panels, turning vanes, and flexible ducts.
 - 6. Division 23 for Diffusers, Registers, and Grilles.
 - 7. Division 23 for air balancing and final adjusting of manual-volume dampers.

1.3 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula $\text{Btu} \times \text{in.} / \text{h} \times \text{sq. ft.} \times \text{deg F}$ or $\text{W/m} \times \text{K}$ at the temperature differences specified. Values are expressed as Btu or W.
 - 1. Example: Apparent Thermal Conductivity (k-Value): 0.26 or 0.037.
- B. Where any reference to "sheetmetal work" or "ductwork" appears in this section of these specifications or on the drawings, it shall be construed to include air ducts and all other related pieces and parts of the air conveying systems.
- C. NUSIG: National Uniform Seismic Installation Guidelines.

1.4 SYSTEM DESCRIPTION

- A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. 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.

1.5 SUBMITTALS

- A. Product Data: For duct liner and sealing materials.
- B. Delegated-Design Submittal:
 - 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports
- C. Shop Drawings: Show details of the following:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Duct layout indicating pressure classifications, duct sizes, and bottom of duct elevations on plans.
 - 3. Fittings.
 - 4. Reinforcement and spacing.
 - 5. Seam and joint construction.
 - 6. Penetrations through fire-rated and other partitions.
 - 7. Terminal unit, coil, and humidifier installations.
 - 8. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.
- D. 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Other systems installed in same space as ducts.
 - 4. Ceiling and wall mounted access doors and panels required to provide access to dampers and other operating devices.
 - 5. Structural members to which duct will be attached.
 - 6. Size and location of initial access modules for acoustical tile.
 - 7. Penetrations of smoke barriers and fire-rated construction.
 - 8. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.

- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- f. Perimeter moldings

E. LEED Submittals:

- 1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- 2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- 3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
- 4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
- 5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
- 6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products 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."

F. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

- 1. Ceiling suspension assembly members.
- 2. Other systems installed in same space as ducts.
- 3. Ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
- 4. Coordination with ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.

G. Welding Certificates: Copies of certificates indicating welding procedures and personnel comply with requirements in "Quality Assurance" Article.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

I. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.6 QUALITY ASSURANCE

- A. Welding Standards: Qualify welding procedures and welding personnel to perform welding processes for this Project 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. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.
- C. Comply with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems," unless otherwise indicated.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- A. Store and handle sealant and firestopping materials according to manufacturer's written recommendations.
- B. Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. General Material Requirements: 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: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316; cold rolled, annealed, sheet. Exposed surface finish shall be No. 4 and Type 316. For concealed ducts surface finish shall be No. 2D and Type 304.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- 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.
- H. Each sheet shall be stenciled with manufacture's name and gauge. If coil steel is used, coils shall be stenciled throughout on 10-foot centers with manufacture's name and gauge.

2.2 DUCT LINER

- A. Acceptable Manufacturers:
 - 1. Manville, equal to Permacote Linacoustic
 - 2. Owens Corning
 - 3. Certainteed
- B. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive 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."
- C. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive 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."
- D. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- E. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 7. 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.
 8. 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:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
 9. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional; when used, secure build-outs to duct walls with bolts, screws, rivets, or welds.

2.3 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 3 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
 - 10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 - 11. Service: Indoor or outdoor.
 - 12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for building materials.
- B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.
 - 2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.
- 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 ductwork.

2.5 RECTANGULAR DUCT FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply 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 classification.
 - 2. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select L-1 or L-3 seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. 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 unbraced panel area, unless ducts are lined.

2.6 ROUND AND FLAT-OVAL DUCT FABRICATION

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Spiral, lapped or butt weld seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Longitudinal Seams," are acceptable for static-pressure class, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Snaplock seams are not acceptable.
 - 1. A lapped longitudinal seam shall be sealed.
 - 2. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 3. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.7 ROUND AND FLAT-OVAL SUPPLY AND EXHAUST FITTING FABRICATION

- A. 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 duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate bend radius of die-formed, gored, and pleated elbows one and one-half times elbow 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 26 Inches in Diameter: 0.028 inch.
 - b. Ducts 27 to 36 Inches in Diameter: 0.034 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 14 Inches in Diameter: 0.028 inch.
 - b. Ducts 15 to 26 Inches in Diameter: 0.034 inch.
 - c. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
 - 4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal seam flat-oval duct.
 - 5. 90-Degree, Two-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material-handling classes A and B; and only where space restrictions do not permit using 1.5 bend radius elbows. Fabricate with single-thickness turning vanes.
 - 6. Round Elbows, 8 Inches and Smaller: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate non-standard bend-angle configuration or nonstandard diameter elbows with gored construction.
 - 7. Round Elbows, 9 through 14 Inches: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees, unless space restrictions require a mitered elbow. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.
 - 8. Round Elbows, Larger than 14 Inches, and All Flat-Oval Elbows: Fabricate gored elbows, unless space restrictions require a mitered elbow.

9. Die-Formed Elbows for Sizes through 8 Inches and All Pressures: 0.040 inch thick with two-piece welded construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal seam flat-oval duct specified above.
12. Pleated Elbows for Sizes through 14 Inches and Pressures through 10-Inch wg: 0.022 inch.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings. Duct dimensions on plans indicate clear air path/clear inside dimension of ductwork.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.
- C. Construct and install each duct system for the specific duct pressure classification indicated.
- D. Install round and flat-oval ducts in lengths not less than 12 feet, unless interrupted by fittings.
- E. Install ducts with fewest possible joints.
- F. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- G. Install couplings tight to duct wall surface with a minimum of projections into duct.
- H. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.
- I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- K. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- L. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- M. Electrical Equipment Spaces: Route ductwork 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 space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four 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 damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Firestopping."
- P. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic forces required by applicable building codes. Refer to SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems".

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 HANGING AND SUPPORTING

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 2. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.

- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes:
 - 1. All longitudinal and transverse joints, seams and connections of supply and return ducts shall be securely fastened and sealed with welds, gaskets, mastics, mastic-plus-embedded-fabric systems or tapes installed in accordance with the manufacturer's installation instructions.
 - 2. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 3. Outdoor, Supply-Air Ducts: Seal Class A.
 - 4. Outdoor, Exhaust Ducts: Seal Class A.
 - 5. Outdoor, Return-Air Ducts: Seal Class A.
 - 6. Exhaust Ducts: Seal Class A.
 - 7. Unconditioned Space, Supply-Air Ducts: Seal Class A.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class A.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 CONNECTIONS

- A. Connect equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. For branch, outlet and inlet, and terminal unit connections, comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:

- a. Exhaust duct systems.
 - b. Supply ducts with a Pressure Class Higher Than 2-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 1. Visually inspect duct system to ensure that no visible contaminants are present.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 PAINTING

- A. All interior lined duct system that are exposed shall be of paint grip sheet metal or prep and primed for field painting.
- B. Paint exterior of all ducts and insulation systems that are visible through ceiling systems.
- C. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 ADJUSTING

- A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.
- B. Refer to Division 23 Section "Testing, Adjusting and Balancing" for detailed procedures.

3.9 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:

1. Ducts Connected Downstream to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 1-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- C. Return Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Exhaust Ducts:
1. Ducts Connected to Vehicle Exhaust Systems (ASHRAE 62.1, Class 3 and 4) Air:
 - a. Pressure Class: Negative or Positive 6-inch wg.
 - b. Minimum SMACNA Seal Class: A.

- c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 - 2. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative or Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. All Ducts:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- F. Duct Liner:
 - 1. All exposed supply, return and outdoor air ductwork in interior conditioned space shall be internally lined.
 - 2. Supply, return and exhaust ductwork shall be internally lined a minimum of 10 feet from the air handler, rooftop unit or fan.
 - a. 1-1/2 inch thick liner for supply air.
 - b. 1 inch thick liner for return air.

3.1 FITTINGS

A. Elbow Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

- 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- B. Branch Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - DUCT 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. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Combination fire and smoke dampers.
6. Turning vanes.
7. Duct-mounting access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.

- B. Related Sections include the following:

1. Division 26 Section "Fire Alarm" for duct-mounting fire and smoke detectors.

1.3 SUBMITTALS

- A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Motorized control dampers.
4. Fire dampers.
5. Combination fire and smoke dampers.
6. Turning vanes.
7. Duct-mounting access doors.
8. Flexible connectors.
9. Flexible ducts.

- 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 Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
 - C. 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. Wiring Diagrams: Power, signal, and control wiring.
 - D. 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.
- 1.4 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."

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 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 Standards 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**.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Ruskin Company.
 - 3. Air Balance, Inc.
 - 4. Greenheck
 - 5. Metalaire
 - 6. Nailor
 - 7. Pottorff
- B. Description: Multiple-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: **0.052-inch** thick, galvanized sheet steel, with welded corners and mounting flange.
- D. Blades: **0.025-inch** thick, roll-formed aluminum.
- E. Blade Seals: Neoprene.
- F. Blade Axles: Galvanized steel.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.

2.4 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company.
 - 2. Air Balance, Inc.
 - 3. Greenheck
 - 4. Metalaire
 - 5. Nailor
 - 6. Pottorff

7. Flexmaster U.S.A., Inc.
- 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.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, 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 Steel Blades: 0.064-inch thick, galvanized sheet steel.
 3. Aluminum Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Bearings: Oil-impregnated bronze.
 8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.
- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: U-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, 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 Steel Blades: 0.064-inch thick, galvanized sheet steel.
 3. Aluminum Frames: U-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Bearings: Oil-impregnated bronze thrust or ball.
 8. Blade Seals: Neoprene.
 9. Jamb Seals: Cambered aluminum.
 10. Tie Bars and Brackets: Galvanized steel.
- E. Jackshaft: 1-inch diameter, galvanized-steel pipe 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. Provide indicating quadrant and locking device dampers.

2.5 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
 2. Pottorff
 3. Ruskin Company.
 4. American Warming and Ventilating; a division of Mestek, Inc.
- B. Low-leakage rating Class 1 per IECC and ASHRAE 90.1 Less than 3 cfm/sq ft at 1" static pressure with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
 2. Galvanized -steel channels, 0.064 inch thick.
 3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 8 inches.
 2. Opposed-blade design.
 3. Galvanized steel.
 4. 0.064 inch thick.
 5. Blade Edging: Closed-cell neoprene edging.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: ~~1/2-inch~~ diameter; plated steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 25 to plus 180 deg F.
- F. Bearings:
1. Molded synthetic.
 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.
3. McGill AirFlow Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Penn Ventilation Company, Inc.
7. Prefco Products, Inc.
8. Vent Products Company, Inc.
9. Ward Industries, Inc.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream Multiple-blade type; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. 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. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 165 deg F rated.

2.7 SMOKE, COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Ruskin Company.
2. Greenheck.
3. Nailor Industries Inc.
4. Air Balance, Inc.

B. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555 for 1-1/2-hour rating.

C. Fusible Links: Replaceable, 165 deg F rated.

- D. Frame and Blades: 0.064-inch thick, galvanized sheet steel.
- E. Mounting Sleeve: Factory-installed, 0.052-inch thick, galvanized sheet steel; length to suit wall or floor application.
- F. Damper Motors: Provide for modulating or two-position action.
 - 1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 2. 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.
 - 3. 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 minus 40 deg F.
 - 4. 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.
 - 5. Electrical Connection: 115 V, single phase, 60 Hz.

2.8 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.9 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. METALAIRE, Inc.

d. Ward Industries, Inc.

- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.10 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.
- g. Ward 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. Flexmaster U.S.A., Inc.

2. Frame: Galvanized sheet steel, with spin-in notched frame.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers:

- 1. Duro Dyne Corp.
- 2. Ventfabrics, Inc.
- 3. Ward Industries, Inc.

- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip **3-1/2 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. Supply Air ductwork Connection, insulated flexible connection equal to INSULFAB by Duro-Dyne.
- F. 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.**
- G. 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.**

2.12 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Flexmaster U.S.A., Inc.
 - 3. McGill AirFlow Corporation.
- B. Insulated-Duct Connectors: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene, aluminized vapor barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: **4000 fpm.**
 - 3. Temperature Range: **Minus 20 to plus 210 deg F.**
- C. Flexible Duct Clamps: Nylon strap, in sizes **3 through 18 inches** to suit duct size.

2.13 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 and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. 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.
- F. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- H. 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, turning vanes, 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.
- I. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.

6. Body Plus Ladder Access: 25 by 17 inches.

J. 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.

K. Install the following sizes for duct-mounting, pressure relief access doors:

1. One-Hand or Inspection Access: 7 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.
3. Head and Hand Access: 13 inches in diameter.
4. Head and Shoulders Access: 19 inches in diameter.

L. Label access doors according to Division 23 Section "Mechanical Identification."

M. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

N. For fans developing static pressures of 5-inch wg (1250 Pa) and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with draw bands plus sheet metal screws.

Q. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 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."

END OF SECTION 233300

SECTION 233423 - POWER VENTILATORS

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 the following:
 - 1. Centrifugal roof ventilators.
 - 2. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on actual site elevations (4,324-ft Above MSL)
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material gages and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
- 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. Differentiate between manufacturer-installed and field-installed wiring.
- C. Coordination Drawings: Show roof penetration requirements and reflected ceiling plans drawn to scale and coordinating roof penetrations and units mounted above ceiling. Show the following:

1. Roof framing and support members relative to duct penetrations.
 2. Ceiling suspension assembly members.
 3. Size and location of initial access modules for acoustical tile.
 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

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. 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cook, Loren Company.
 2. Greenheck Fan Corp.
 3. Twin City Fans & Blowers.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Description: Belt-driven or direct-driven as scheduled centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle, one-piece, aluminum base with venturi inlet cone.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. 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 and self-aligning ball bearings.
 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 4. Fan and motor isolated from exhaust airstream.
- E. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent. Provide electronically commutated motor and potentiometer dial mounted on motor.
 2. Disconnect Switch: Non-fusible 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; factory wired to close when fan stops.
 5. Motor starter.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Configuration: Built-in raised cant and mounting flange.
 2. Overall Height: 14" (300-mm).

3. Metal Liner: Galvanized steel.
4. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.
5. Mounting Pedestal: Galvanized steel with removable access panel.
6. Curb seal

2.3 IN-LINE CENTRIFUGAL FANS

- A. Description: Belt-driven or direct-driven as scheduled centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly and accessories.
- B. Housing: Square design with heavy-duty galvanized steel, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with inlet cone, and service door.
- D. 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.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent. Provide electronically commutated motor and potentiometer dial mounted on motor.
 2. Companion Flanges: For inlet and outlet duct connections.
 3. 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.
 4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
 5. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 6. Insulated housing.
 7. Motorized Dampers: Opposed-blade dampers.
- G. Capacities and Characteristics: As scheduled on drawings.

2.4 CEILING-MOUNTED VENTILATORS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- C. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

- D. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- E. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 4. Isolation: Rubber-in-shear vibration isolators.
- F. Capacities and Characteristics: As scheduled on drawings.

2.5 PROPELLER FANS

- A. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- B. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- C. Fan Wheel: Replaceable, aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- D. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Fan Drive:
 - 1. Resiliently mounted to housing.
 - 2. Statically and dynamically balanced.
 - 3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 4. Extend grease fitting to accessible location outside of unit.
 - 5. Service Factor Based on Fan Motor Size: 1.4.
 - 6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours
 - 8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- F. Accessories:

1. Backdraft dampers: Gravity dampers
2. Short Wall Housing: Galvanized steel with heavy gauge mounting flanges and prepunched mounting holes. Protective guards of welded steel wire to protect the drive side.
3. Variable Frequency Drive
4. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics: As scheduled on drawings.

2.6 MOTORS

- A. Refer to Division 23 Section "Motors" for general requirements for factory-installed motors.
- B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
- C. Enclosure Type: Guarded dripproof.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Vibration control devices are specified in Division 23 Section "Mechanical Vibration Controls and Seismic Restraints."
- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- D. Install units with clearances for service and maintenance.
- E. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

- A. 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. Flexible connectors are specified in Division 23 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment.

- D. 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.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connection 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. Verify lubrication for bearings and other moving parts.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
7. Disable automatic temperature-control operators.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

- C. 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.

- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- E. Shut unit down and reconnect automatic temperature-control operators.

- F. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

- G. Replace fan and motor pulleys as required to achieve design airflow.

- H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

- B. Adjust belt tension.

- C. Lubricate bearings.

3.5 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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 ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections include the following:
 - 1. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. 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.

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 DIFFUSERS, GRILLES, AND REGISTERS

- A. Manufacturers:

1. Titus.
2. Nailor
3. Price.
4. Krueger

B. Material: Steel.

C. Finish: Baked enamel, white or as indicated in the Contract Documents.

1. Provide minimum R-5 insulation for ducted supply and return air grilles and diffusers.
2. Refer to Schedule for additional accessories.

2.3 BACK OF HOUSE EXTERIOR LOUVERS

A. Manufacturers:

1. Greenheck Fan Corporation
2. Pottorff
3. Ruskin Company

B. Provide storm proof exterior wall louvers; size as indicated on Drawings.

C. Provide 5 year warranty by louver manufacturer.

D. Louvers shall be AMC certified for zero water penetration and maximum 1/8-inch pressure drop at a free area velocity of 900 fpm.

E. Louvers shall be 4" deep constructed of 0.081" thick 6063-TX extruded aluminum complete with 1/2" aluminum screen in removable frame.

F. Frames shall be box type for masonry construction and flange type for frame construction.

G. Louver shall have a clear anodized aluminum finish.

H. Louvers shall be minimum 4" deep, storm proof, wind driven rain resistant, extruded aluminum, drainable, with 1/2" square mesh aluminum screen on interior face.

2.4 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.

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. Refer to Architectural drawings for louver installation details.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 237413 - ROOFTOP UNITS (DX)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged rooftop heating and cooling units.
- B. The manufacturer shall verify that the submitted units' footprint and service clearances fit within spaces allocated on the contract drawings shown for the scheduled units. Manufacturer and Contractor shall comply with 230500 1.6 F before submitting an equipment bid.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each unit scheduled, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; access door, outside air and exhaust louver locations; furnished specialties; accessories including thermostats and remote sensors; and installation and startup instructions.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
- C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists for review.
- E. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 01.
- F. A complete copy of these specifications with each sub-paragraph noted with the comment, "compliance", "deviation", or "alternate". 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", it shall be understood that the supplier is in full compliance with the item specified and will provide exactly the same with no deviations.
 - 2. By noting the term "deviation" it shall be understood that the supplier prefers to provide a different component in lieu of that specified. The supplier shall indicate all deviations.

3. By noting the term "alternate", it shall be understood that the supplier 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 supplier proposes to provide.

G. Warranties: Special warranties specified in this Section.

H. LEED Submittals:

1. Product Data for Credit EA 6: For refrigerants, including printed statement that refrigerants are free of HCFCs.
2. Product Data for Credit EA 3: For continuous metering equipment for outdoor airflow and energy consumption.

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. ASHRAE/IESNA 90.1-2010 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2010, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 210/240, "Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.
- D. Fabricate and label refrigeration system to comply with ASHRAE 15 Standards.
- E. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
- F. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 210/240 and bear the AHRI Certification label.
- G. Comply with ASHRAE 62.1-2010 requirements.
- H. Units shall be designed to operate with HCFC-free refrigerants.
- I. Units shall be designed to operate with HCFC-free refrigerants.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver rooftop units as factory-assembled units with protective crating and covering.
- B. Coordinate delivery of units in sufficient time to allow movement into building.
- C. Handle rooftop units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.6 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.
 - 1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Fan Belts: One set for each size of belt-drive fan.
 - 2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design production: : Contractor must provide manufacturer specified on the drawings. No substitutions allowed unless specified by PNC.

2.2 ROOFTOP UNITS

- A. Description:
 - 1. A factory-assembled and –tested, packaged rooftop unit, designed for roof or concrete slab installation, shall include compressors, evaporator coils, filters, supply, return and exhaust fans (as indicted and with VFD in equipment schedule in Drawings), dampers, air-cooled condenser coils, condenser fans, reheat coil, electric heat strips, and unit controls.
 - 2. Unit shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.

3. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
4. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
5. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
6. Installation, Operation and Maintenance manual shall be supplied within the unit.
7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

B. Construction:

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
2. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break with no metal path from inside to outside the cabinet. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
5. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
6. Access to filters, dampers, cooling coils, reheat coil, heaters, supply fans, exhaust fans, return fans, energy recovery wheels, compressors, water-cooled condensers, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
7. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
8. Units with cooling coils shall include double sloped 304 stainless steel drain pans.
9. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
10. Unit shall include lifting lugs on the top of the unit.

C. Supply, Return and Exhaust Fans:

1. Direct-Driven Fans: Un-housed, backward inclined, centrifugal plenum supply fans; with permanently lubricated, multispeed motor resiliently mounted. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
2. Belt-Driven Fans: Provide belt driven fans with adjustable motor sheaves. Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
3. Blowers and motors shall be dynamically balanced and mounted on spring isolators.
4. Motors shall be premium efficiency, invert duty, open drip proof with ball bearings rated for 200,000 hours of service with external lubrication points.
5. Variable frequency drive shall be factory wired and mounted in the unit for VAV operation.

D. Motors:

1. Refer to Division 23 Section "Motors" for general requirements for factory-installed motors.
2. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
3. Motors and drives shall be factory mounted with entire assembly balanced before shipment. Motors shall be of the open drip-proof type and shall be mounted on an adjustable motor base properly attached to the unit housing. Units scheduled as variable volume to have motors suitable for variable frequency drives. Motors 15 HP and below shall be equipped with adjustable sheaves. Motors 20 HP and larger shall be equipped with fixed drives to handle scheduled conditions, and suppliers shall provide a drive "change-out" to meet actual job conditions if required.

E. Refrigerant Coils:

1. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and Stainless steel end casings. Fin design shall be sine wave rippled.
2. Coils shall have interlaced circuitry and shall be capacity as scheduled.
3. Coils shall be helium leak tested.
4. Coils shall be furnished with a factory installed thermostatic expansion valves.

F. Air-Cooled Condensers

1. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
2. Coils shall be designed for use with R-410A refrigerant and constructed of
 - a. Copper tubes with aluminum (copper) fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - b. Aluminum microchannel tubes, fins and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins and aluminum headers shall be oven-brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements.
3. Coil assemblies shall be factory leak-tested at a minimum of 300 psig .
4. Hot gas and liquid lines shall be copper and shall be brazed.
5. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

6. Coils shall be helium leak tested.
- G. Drain Pans: Drain Pans: Formed sections of stainless steel sheet, a minimum of 2 inches deep and complying with ASHRAE 62.1.
 1. Double slope, double wall stainless steel construction. Fill space between walls with foam insulation and seal moisture tight.
 2. Drain Connections: Threaded nipple on one side of drain pan.
 3. Provide condensate overflow switch.
- H. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 indicated in the equipment schedules. Provide external dial magnehelic gauge with design filter pressure drop indication.
- I. Refrigeration System
 1. Unit shall be factory charged with R-410A refrigerant.
 2. Compressors shall be scroll type with thermal overload protection, independently circuit-ed, and carry a 5 year non-prorated warranty.
 3. For units over 10-Tons:
 - a. Provide two minimum refrigerant circuits.
 - b. Each refrigeration circuit shall include two equally sized compressors.
 4. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation.
 5. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 6. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
 7. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter driers.
 8. Each capacity stage shall be equipped with an adjustable delay start timer to prevent multiple stages from starting all at once.
 9. Crankcase heaters shall be utilized with all scroll compressors.
 10. Where scheduled, unit shall include a variable capacity scroll compressor on the lead refrigeration circuit(s) which shall be capable of modulation from 10-100% of its capacity with additional single compressor stages of capacity control.
 11. Where scheduled, the lead refrigeration circuit shall be provided with hot gas reheat coil, modulating control valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. In lieu of modulating scroll compressor, hot gas bypass on all circuits may be provided.
 12. Each refrigeration circuit shall be equipped with a liquid line sight glass, filter/dryer and discharge and suction service valves.
- J. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - a. Mercury contactors.
 - b. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - c. Time-delay relay.
 - d. Airflow proving switch.

K. Outside Air / Air-Side Economizer Section:

1. Enthalpy based air-side economizer with a barometric relief, return air or exhaust air fan as scheduled on the equipment schedules.
2. Unit shall include 0-100% damper assemblies consisting of a motor operated outside air, return air and relief air damper assemblies constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2 inches w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return fully modulating actuator.
3. Unit shall include outside air opening bird screen, outside air hood with rain lip and barometric relief dampers.
4. Provide airflow measurement station to measure and maintain scheduled minimum outside air. The system shall include multiple total and static pressure sensing ports to comply with ASHRAE Standard 111 for duct traversing and AMCA certified to within +/- 5% and minimum velocity at 100 fpm. Construction shall include a galvanized casing with anodized aluminum flow sensors. Airflow stations shall maintain accuracy from 0-100% humidity and not susceptible to condensation. Provide DDC signal processing transducer with thermoplastic or copper tubing to airflow measurement station. The transducer shall integrate to unit DDC controls, include serial communication compatible, or provided by, to building automation system company.

L. Electrical

1. Unit shall be provided with standard power block for connecting power to the unit with a fused disconnect.
2. Provide control circuit transformers with built-in over-current protection.
3. Provide an unpowered WP/GFI convenience outlet (110V / 20 amp).
4. Minimum withstand rating (SCCR) shall be as required by electrical power distribution system, but not less than shown on the equipment schedules. Contractor shall verify the required minimum withstand rating with Division 26.

M. ACCESSORIES

1. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
2. Condenser fan guards of painted, galvanized-steel wire.

3. Hail guards of galvanized steel, painted to match casing.

N. Controls

1. Manufacturer shall review Specification Section 230900 Sequence of Operations for HVAC Controls to coordinate factory provided controls with project requirements.
2. Factory Installed and Factory Provided Controller
 - a. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
 - b. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
 - c. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
 - d. With enthalpy activated fully modulating economizer option, an outdoor air humidity sensor shall be factory installed.
 - e. Where scheduled with a modulating hot gas reheat option, a space humidity sensor and supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity set points, for the dehumidification mode of operation, shall be adjustable.
 - f. Controller
 - 1) Units shall be equipped with variable capacity lead compressor or hot gas bypass on all refrigeration circuits for capacity control and to protect against evaporator frosting at low suction pressures.
 - 2) Outside air temperature sensor and suction pressure transducer shall be factory mounted and wired. Supply air temperature sensor and space temperature sensor with temperature set point reset and unoccupied override shall be furnished with the unit for field installation.
 - 3) Unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, set point adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with a BACnet network.
3. Alternately, unit DDC controls and sensors may be provided by building automation system provider, given that all specified functions, set points, monitoring points are provided.
4. Electronic Controller:
 - a. Controller shall have volatile-memory backup.
 - b. Safety Control Operation:
 - 1) Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.

- 2) Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 284621 " Digital Addressable Fire-Alarm System."
 - 3) Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
 - c. Fan Operation:
 - 1) Occupied Periods: Run fan continuously.
 - 2) Unoccupied Periods: Cycle fan to maintain setback temperature.
 - d. Refrigerant Circuit Operation:
 - 1) Occupied Periods: Cycle or stage compressors and operate hot-gas bypass to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - 2) Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
 - 3) Switch reversing valve for heating or cooling mode on air-to-air heat pump.
 - e. Hot-Gas Reheat-Coil Operation:
 - 1) Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
 - 2) Unoccupied Periods: Reheat not required.
 - f. Electric-Resistance Heating Coil:
 - 1) Capacity: See plans
 - 2) Number of Steps: SCR.
5. Economizer Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to outside air damper to provide the scheduled minimum outside air and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. During economizer cycle operation, lock out cooling.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.3 EQUIPMENT CURBS

- A. Equipment curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Mechanical Vibration Controls."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. The equipment curbs mounted on a concrete slab shall have an insulated bottom.
 - b. Liner Adhesive: Comply with ASTM C 916, Type I.
 - c. 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.
 - d. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - e. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 14 inches

2.4 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate capacity according to ARI Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roof for compliance with requirements for conditions affecting installation and performance of rooftop units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 1. Install RTUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.
 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Mechanical Vibration Controls"
- B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- C. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- D. Install units according to manufacturer's written instructions.
- E. Install units level and plumb, maintaining manufacturer's recommended clearances.
- F. Coordinate outside air intake locations with exhaust fans and plumbing vents.

- G. To protect the equipment during construction and for the purpose of testing and balancing, contractor shall provide a complete set of temporary filters. These temporary filters shall be of glass fiber in a heavy cardboard frame with suitable retainers to hold the media in place. After air systems have been cleaned, tested and approved, these temporary filters shall be removed and replaced with clean filters as schedules and specified.
- H. Curb Support: Install roof curb on roof structure, level, according to NRCA's written installation instructions. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.
- I. Unit Support: Install unit on structural curbs and level. Coordinate wall penetrations and flashing with wall construction.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping to allow service and maintenance.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination in roof mounting frames. Where indicated, terminate return-air duct through roof structure and insulate space between roof and bottom of unit.
- C. Electrical: Conform to applicable requirements in Division 26 Sections.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

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. 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. Report results in writing.
- C. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.

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.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service. Retain paragraph below to require a factory-authorized service representative to perform inspections, tests, and adjustments.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 1. Inspect for visible damage to unit casing.
 2. Inspect for visible damage to furnace combustion chamber.
 3. Inspect for visible damage to compressor, coils, and fans.
 4. Inspect internal insulation.
 5. Verify that labels are clearly visible.
 6. Verify that clearances have been provided for servicing.
 7. Verify that controls are connected and operable.
 8. Verify that filters are installed.
 9. Clean condenser coil and inspect for construction debris.
 10. Clean furnace flue and inspect for construction debris.
 11. Remove packing from vibration isolators.
 12. Inspect operation of barometric relief dampers.
 13. Verify lubrication on fan and motor bearings.
 14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 15. Adjust fan belts to proper alignment and tension.
 16. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 17. Inspect and record performance of interlocks and protective devices; verify sequences.
 18. Operate unit for an initial period as recommended or required by manufacturer.
 19. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Inspect operation of power vents.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 20. Calibrate thermostats.
 21. Adjust and inspect high-temperature limits.
 22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. Low-temperature safety operation.
 - b. Filter high-pressure differential alarm.
 - c. Economizer to minimum outdoor-air changeover.
 - d. Relief-air fan operation.
 - e. Smoke and firestat alarms.
28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 2. Review data in the maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
 3. Schedule training with Owner, through Architect, with at least 07 days' advance notice.

END OF SECTION 237413

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

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 split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. Indoor units cabinet are designed for exposed mounting.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories including controllers 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: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For split-system air-conditioning units to be included in emergency operation and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 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 1 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. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

- D. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 210 and bear the AHRI Certification label.
- E. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- F. A dry air holding charge shall be provided in the indoor section.

1.5 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 3 Section "Cast-in-Place Concrete."
- B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 Warranty: Manufacturer's standard form in which manufacturer and contractor agrees to provide labor and material and components to replace components of rooftop air conditioners which fail in due to materials, workmanship or improper startup within specified warranty period.

- 1. Warranty Period for Components unless specifically mentioned: Manufacturer's standard, but not less than one year from date of Substantial Completion.
- 2. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
- 3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mitsubishi Electric
 - 2. Carrier Air Conditioning; Div. of Carrier Corporation.
 - 3. Daikin

2.2 INDOOR EVAPORATOR UNIT

- A. The indoor unit cabinet shall wall mounted by means of a factory supplied mounting plate and be fabricated and formed from high strength molded plastic with front panel access for filter cleaning and service.

- B. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan and motor.
- C. The indoor unit coil shall be of nonferrous construction of aluminum fins on copper tubing. All joints shall be brazed with silver alloy and coil shall be pressure test at the factory. A condensate pan and drain shall be provided under the coil.
- D. The indoor unit fan shall be a high performance, double inlet, forward curve direct-drive fan. The fans shall be statically and dynamically balanced. The motor shall have permanently lubricated bearings.
- E. The return air filter shall be a permanent washable type.

2.3 OUTDOOR AIR-COOLED CONDENSER UNIT

- A. The outdoor unit shall be designed and assembled by the same manufacturer and selected as a compatible match as the indoor unit. The outdoor unit shall be completely factory assembled, piped, wired and tested. The split system shall be capable of operating with the outdoor unit 100 feet higher than the indoor unit and 165 feet of maximum refrigerant tubing length between the indoor and outdoor units without the need for line size changes, traps or additional oil.
- B. The outdoor unit shall be constructed from galvanized steel plate, coated with an exterior paint finish tested to withstand a minimum 750-hour salt spray test in accordance with ASTM B117.
- C. The outdoor unit coil shall be of nonferrous construction of flat aluminum fins on copper tubing. Coil shall be protected from damage by an internal metal guard. The system's capacity control shall be by the means of a microprocessor controlled step motor controlling a linear expansion valve (LEV) metering orifice.
- D. The outdoor unit fan shall be an axial type direct-drive fan, arranged in a horizontal draw-through configuration. The fan shall be statically and dynamically balanced. The motor shall have permanently lubricated bearings. The fan shall be provided with a guard.
- E. The outdoor unit compressor shall be a DC rotary compressor with variable compressor speed inverter technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match room load. The outdoor unit compressor shall be mounted on resilient rubber isolators. The refrigerant circuit as be provide with the following:
 - a. Gauge ports and Schrader type service fittings on the high and low pressure sides,
 - b. Sight-glass and liquid line dryers,
 - c. Anti-slug protection,
 - d. Crankcase heater
 - e. Manual reset motor overload protection, and
 - f. Anti-short cycling time delay control preventing the compressor from restarting for five minutes after cycling off.
- F. The outdoor unit shall be capable of operating at a 0 degrees F ambient temperature with additional low ambient controls.

2.4 SYSTEM CONTROLS

- A. The system's control system shall consist of two (2) microprocessors, one on each indoor and outdoor units, interconnected in the field by two (2) 20 ga AWG wire.
- B. The indoor unit shall be connected to wall mounted wired controller to display system parameters and perform input functions. The indoor controller shall provide on/off control, space temperature set point control, fan speed selector and display system diagnostics, status and faults. The controller shall have a built-in temperature sensor.
- C. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostic ability.

- 2.5 Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the indoor and outdoor units level and plumb using manufacturer's standard mounting devices securely fastened to building structure.
- B. Install roof-mounting compressor-condenser components on equipment supports specified in Division 7 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- C. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

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 unit to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. 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 1 Section "Closeout Procedures."

END OF SECTION 238126

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SCOPE

- A. This Division and the accompanying electrical drawings cover furnishing all labor, equipment and materials and performing all operations in connection with the installation of complete electrical systems as documented on plans and specifications.
- B. There are many interfaces between the work involved with this Division and the work in other Divisions, particularly with those divisions pertaining to HVAC and Plumbing. Be aware of the responsibilities at the interfaces. The exact locations of apparatus, fixtures, equipment and raceways shall be ascertained from all concerned and the work shall be laid out accordingly. In addition, coordinate with all equipment suppliers and other trades to verify the actual installation requirements prior to rough-ins.
- C. The plans and specifications are considered cooperative and complimentary. Where one contradicts the other, notify the Architect/ Engineer for clarification prior to any installation.
- D. All applicable portions of the General and Specific Conditions are included herein by reference.

1.4 CODES AND REGULATIONS

- A. All work shall comply with all local laws, ordinances and regulations applicable to the electrical and fire alarm/life safety system installation, NFPA, OSHA, ANSI, SBC municipal ordinances governing electrical work, and with the requirements of the National Electrical Code (NEC) utilize the latest edition approved by the authority having jurisdiction (AHJ).
- B. Where different sections of any of the aforementioned codes and regulations, the specifications or the plans require different materials, methods of construction, or other requirements, the most

restrictive or stringent shall govern. In any conflict between a general provision and a special provision, the special provision shall govern.

- C. Obtain all permits and licenses, and pay all fees as required for execution of the Contract. Arrange for necessary inspections required by the Architect, city, county, state and other authorities having jurisdiction (AHJ) and present certificates of approval to the Owner or his designated representative.
- D. Under no circumstances will asbestos, or asbestos related materials, be allowed on this project.
- E. Communicate with all required utility offices to meet utility schedules and regulations. Coordinate the local utility requirements with the requirements of these contract documents. Should conflicts arise, notify the Architect/Engineer immediately. Acquire services to avoid project delays. Conform to regulations of the local utility company with respect to metering, service entrance and service access.

1.5 SITE VISIT

- A. All interested parties shall visit the site and thoroughly familiarize themselves with the local conditions and existing conditions which may affect the cost of the Work in advance of any project activity or submission of bids.
- B. Where work under this Division requires extension, relocation, reconnection or modifications to the existing equipment or systems, the existing equipment or systems shall be restored to their original condition prior to completion of this Project.
- C. No allowances will be made for lack of knowledge of job conditions which could reasonably be identified during site visit.
- D. Verify the service entrance voltage and short circuit contribution with the serving power utility and provide written confirmation of same to the Architect prior to submitting shop drawings or ordering any materials for use in the building served. Provide service entrance equipment fully rated to interrupt the available fault current from the serving utility.

1.6 DRAWINGS AND SPECIFICATIONS

- A. The Electrical Drawings are diagrammatic and are not intended to show the exact location of raceways, outlets, boxes, bends, sleeves, fire sealant, couplings or other such elements except where dimensions are noted. Provide all required offsets, extensions or pull boxes required for a fully coordinated and operational system.
- B. The Drawings and Specifications shall both be considered as part of the Contract. Any work or material shown in one and omitted in the other, or which may fairly be implied by both or either, shall be provided in order to give a complete job.
- C. Should conflicts exist between the Drawings and Specifications, notify the Architect/Engineer for clarification prior to installation.

- D. Refer to the Civil, Architectural, Structural and Mechanical plans and shop drawings and details for dimensions, and fit the work to conform to the details of building construction.
- E. Review the drawings for door swings, cabinets, millwork, counters and other built-in equipment. Coordinate installation of the electrical equipment with structural systems and mechanical systems such that full maintenance access is provided.
- F. All conduit and wiring shown on the Electrical Drawings shall be provided under this Division regardless of its function.
- G. Review the drawings and specifications provided for other systems such as Sound System, CATV, Computer, Landscape, etc., for additional work which may be required under this Division. Provide service to and make connections to all such equipment requiring electrical service.
- H. Equipment configuration is based upon one manufacturer's product. Where the equipment selected by the Contractor for use on this Project differs from the configuration shown, the Contractor shall be responsible for coordinating space requirements, connection arrangements, interfaces with mechanical and plumbing equipment and all other affected trades and providing access for future maintenance and repair. Submit proposed revisions for approval by the Architect/Engineer

1.7 EQUIPMENT CONNECTIONS

- A. The horsepower, wattage (or amperes) of mechanical equipment indicated is the estimated requirement of equipment furnished under another Division. All wiring, protective devices and disconnect switches shall be of the voltage, size and ampacity required for the actual equipment installed, without increase or additional costs. In no case shall these items be of smaller capacity than permitted by National Electrical Code.
- B. Coordinate with other trades and review the drawings of other divisions. Conform to UL Listing and nameplate requirements for equipment furnished. Such adjustments shall be subject to the approval of the Architect/Engineer.
- C. Branch circuits supplying control panels and other equipment master and local unit locations and quantities shall be coordinated at the submittal stage and provided under this Division. Provide emergency power where required to accomplish emergency equipment operations in accordance with other Divisions requirements. All control wiring for plumbing and heating, ventilation and air conditioning systems shall be installed under their respective division. Review HVAC & Plumbing Division specifications and shop drawings for control systems to assure system compatibility between equipment furnished under this Division and system wiring and controls furnished under those Divisions.
- D. Motor controllers shall be installed by this Division where automatic control of equipment is required, unless specified to be furnished as an integral part of packaged equipment. Power wiring to all motors and motor controllers and between motors and controllers shall be furnished under this Division.
- E. For each electrical connection required, provide pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire connectors, and

other items required to complete splices and terminations of the necessary types. Cover splices or terminations with electrical insulation equivalent to insulation of conductors terminated

1.8 ELECTRICAL OUTAGE SCHEDULING

- A. Electrical work requiring interruption of electrical power which would adversely affect the Owner's operation shall be done at times other than normal working hours. Coordinate with Owner to establish normal working hours for this facility.

1.9 COORDINATION

- A. 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 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.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with selection and application of firestopping.

1.10 AS-BUILT (RECORD) DRAWINGS

- A. Maintain on the job site at all times during construction a set of "As-Built" drawings with all changes during construction marked thereon. This set shall be utilized for no other purpose. Include any addenda, change orders, field orders, project sketches or "marked-up" drawing prints as may be generated on the job site to assist in recording the changes.
- B. The "As-Built" drawings shall show all changes and deviations from the Contract Drawings including relocation of outlets, conduit and equipment. Record final dimensioned locations of switchboards, panelboards, transformers, disconnect switches, etc. Make sufficient measurements to locate all new underground conduit. Show exact locations of new underground cable and conduits, both interior and exterior, fully dimensioned from building column lines or permanent exterior structures. These drawings shall be available for reference at the time of final inspection.
- C. Submit red line as-builts to architect. Submission of Engineer's drawings for shop drawings and unaltered Engineer's drawings for "As-Built" will not be acceptable

1.11 MAINTENANCE AND CONSTRUCTION MANUALS

- A. (FPA recommend to keep as part for close out docs) Submit to the Architect/Engineer, upon completion of the work and prior to final inspection, copies of maintenance and instruction manuals for equipment provided as outlined below:
 - 1. Three sets of the following data are required:
 - a. Operating and maintenance instructions.
 - b. Spare part list.
 - c. Copies of approved submittal data.
 - d. Copies of panelboard circuit directories reflecting all field changes.
 - e. Test reports of all tests performed.
 - f. Certificates of inspection from AHJ.
 - g. Contact names and phone numbers for parts suppliers of submitted equipment.

PART 2 - PRODUCTS

2.1 STANDARDS FOR MATERIALS AND WORKMANSHIP

- A. All material shall be new and shall bear the inspection label of Underwriter's Laboratories, Inc. (UL).
- B. The published standards and requirements of the National Electrical Manufacturer's Association (NEMA), Underwriters' Laboratories (UL), Electrical Testing Laboratories (ETL), American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), Insulated Cable Engineers Association (ICEA), National Fire Protection Association (NFPA) and the American Society for Testing and Materials (ASTM) shall govern and apply where such have been established for the particular material in question.
- C. Specified catalog numbers and trade or manufacturers names are intended to describe the material, devices, or apparatus desired for type, construction features, electrical characteristics, ratings, operating functions, style and quality. Similar materials of other manufacturers, not less than specified quality, capacity or character may be substituted in conformity with the provisions of the General and Supplementary Conditions. Materials of the same type shall be the product of one manufacturer. Refer to Shop Drawing requirements.
- D. Furnish all materials specified herein or indicated on the drawings.
- E. All work shall be installed in a practical and workmanlike manner by competent workmen, skilled in their trade.
- F. Provide complete electrical characteristics for all equipment. Submit for approval data of the materials and equipment to be incorporated into the Work. Submittals shall include descriptive materials, catalog cuts, diagrams, performance characteristics, and charts published by the manufacturer indicating conformance to the specification and drawing requirements; model numbers alone will not be acceptable. Submittals shall be made by Specification section number, tabbed, within three ring binders, grouped and submitted in packages as indicated below. Submittals for lighting fixtures shall include full photometric data. Shop drawings shall be submitted for the following equipment and items suitably bound, and marked:
 - 1. Package I

- a. SECTION 262416 - PANELBOARDS
- b. SECTION 262713 - ELECTRICITY METERING
- c. SECTION 264313 - TRANSIENT-VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS
- 2. Package II
 - a. SECTION 260923 - LIGHTING CONTROL DEVICES
 - b. SECTION 262726 - WIRING DEVICES
 - c. SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS
- 3. Package III
 - a. SECTION 265119 - INTERIOR LIGHTING
 - b. SECTION 265213 - EMERGENCY AND EXIT LIGHTING
- G. Shop drawings and/or catalog data submittals on all items of equipment and materials shall be submitted in conformity with requirements of the General and Supplementary Conditions. Do not submit more than the required number of sets. Do not submit equipment or materials not requested in the Specifications.
- H. All material lists and shop drawing submittals shall include a stamped indication by the Contractor signifying that the submittals have been previously reviewed for complete compliance with the Contract Documents, that all coordination required between trades prior to field installation has occurred and that the material being submitted is approved for installation. The stamped indication shall include the name of the contracting firm, the date of the review and the signature of the contractor. The Engineer will not review the shop drawing submittals without the contractor's stamped approval already on the shop drawings. The responsibility of complying with the Contract Documents will not be relieved by the Engineer's review, which requires 10 working days from the date the shop drawings are received by the Engineer.
- I. All pricing is to be based upon the products, manufacturers, and processes described in the Contract Documents. Requests for approval of substitutions shall be written and delivered to the Architect's/Engineer's office in conformity with the provisions of the General and Supplemental Conditions. Do not submit any shop drawing or product data that does not conform with the contract documents.
- J. Resubmittals, if necessary, shall be made as specified above. Resubmittals will highlight and indicate any and all revisions made thereto and will include the following text "Resubmittal #___", typed in a prominent location on the cover sheet.
- K. The Contractor shall provide with the shop drawing submittal dimensioned layouts of all electrical rooms and spaces using the equipment he intends to furnish. Switchboard, panelboards, distribution panels, etc., will be rejected without dimensioned room layouts.
- L. Submittals shall be noted with any deviations, alterations or limitations of product from the specified materials. The product will be rejected upon failure to indicate this information. Any conflict or failure to perform comparably to the originally specified materials will result in product rejection. It will be the Contractor's responsibility to replace the alternate material or equipment with the originally specified one and to demolish, replace, repair and retest the equipment, including repair or replacement of any component of the building, finishes or other systems affected by said replacement, at no additional costs to the Owner.

2.2 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. 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 (1270 mm) and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

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 ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. 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.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Before any piping, conduit, outlets, equipment or lighting fixtures are located in any area, coordinate the space requirements with all trades. Such shall be arranged so that space conditions will allow all trades to install their work, and will also permit access for future maintenance and repair. Coordinate the installation of recessed electrical equipment with concealed ductwork, piping, insulation, structural appearances and wall thickness.
- G. Piping, ductwork, conduit and equipment installed at variance with the above requirements shall be relocated and/or revised to conform with the above requirements without incurring additions to the Contract.

- H. Coordination of space requirements with all trades shall be performed so that:
- I. No piping or ductwork, other than electrical, shall be installed within dedicated space of panelboards, switchboards or transformers identified by NEC.
- J. Do not scale drawings. Obtain dimensions for layout of equipment from the Architectural drawings unless noted on the Electrical drawings

3.2 PROTECTION OF MATERIALS

- A. Refer to the general requirements section of the Specifications for storage, protection and handling requirements.
- B. Provide dry, weathertight staging and storage for materials and equipment requiring protection from weather and moisture per manufacturer's recommendations. Install temporary lighting or heat sources to prevent moisture accumulation. Provide protection against direct sunlight, precipitation, wind, ice, fire or excessive heat. Store materials in original undamaged packaging with manufacturer's labels and seals intact. Containers which are broken, damaged or watermarked are not acceptable and are subject to rejection.
- C. Materials and equipment will not be installed until the environmental conditions of the project are suitable to protect same per manufacturer's recommendations. Equipment or materials damaged or subjected to moisture, precipitation, direct sunlight, cold or heat are not acceptable and shall be removed from the project and replaced at no additional costs to the Owner.
- D. All conduit and other openings shall be kept protected to prevent entry of foreign matter or construction debris. Fixtures, equipment, and apparatus shall be kept covered for protection against dirt, water, chemical or mechanical damage before and during construction.
- E. The original finish, including shop coat of paint of fixtures, apparatus or equipment that has been damaged shall be restored without incurring additions to the Contract in time or price.

3.3 CUTTING AND PATCHING

- A. (FPA recommend to keep this note) The Contractor is responsible for all cutting and patching, including escutcheon plates where necessary..

3.4 CLEANING AND PAINTING

- A. Remove foreign materials, drywall compound, overspray, oil, dirt and grease from all raceway, fittings, supports, boxes, cabinets, pull boxes, panelboard trims and equipment to provide clean surfaces for painting. Remove surface oxidation and restore galvanized surfaces with cold process galvanizing compounds. Touchup marred or scratched surfaces of fixtures, panelboard and cabinet trims, motor control centers, switchboards, cabinets, and equipment enclosures with paint furnished by the equipment manufacturer specifically for that purpose.
- B. Do not paint trim hinges, latches, clamps, locks, device covers or trim covers. Mask or remove such items prior to finishing.

- C. Unless otherwise noted herein, all painting shall conform to the "Painting" section of the specifications.
- D. Where plywood backboards are utilized to mount electrical or electronic equipment provided under Division 16, finish same with two (2) coats of light gray semi-gloss paint.

3.5 ACCESS TO ELECTRICAL ITEMS

- A. Install all concealed electrical equipment, junction and pull boxes, apparatus, or devices so as to maintain access for maintenance, operations and replacement. Access doors or covers shall be provided where required by NEC or AHJ and shall be installed in accordance with manufacturer's instructions. Refer to the Architect for approved types, means, methods and appearance. Locate each access unit accurately in relation to electrical work requiring access.

3.6 ELECTRICAL ROOM AND CLOSETS

- A. Manufacturer's equipment shall not be larger than that dimensioned, or scaled, on plans. Conflicts shall be brought to the attention of the Architect, for resolution prior to ordering equipment.
- B. Clear working space in electric rooms and closets shall be no less than required by the N.E.C.
- C. Submit for review, prior to construction or purchase of any equipment, scaled drawings of electrical rooms, closets, or spaces showing, in detail, planned installation locations of the equipment. These shall clearly show compliance with A and B above.

3.7 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 for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. 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 fire stop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. 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.

- H. 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.
- I. 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 fire stop materials.
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel 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.
- L. Underground, Exterior-Wall Penetrations: Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.8 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.

3.9 EXCAVATION AND BACKFILLING

- A. Provide and perform all excavation required to install conduit, ductbanks and manholes indicated on the drawings and/or specified. Trenches shall be of uniform width required with minimum 8" clearance on both sides. Remove and dispose of all materials not to be used for backfill. Maintain dry excavations for electrical work, by removing water. Grade areas to prevent surface water from entering excavation. Remove any accumulated water by pumping. Perform all excavation by open cut. Excavate with vertical-sided excavations where possible. Where necessary, provide sheeting and cross-bracing to sustain sides of excavations. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Establish requirements for trench shoring and bracing to comply with local codes and AHJ..
- B. The bottom of all trenches and excavation shall be graded to provide uniform bearing surface for conduits or ductbanks on undisturbed soil at every point along entire length. Tamp over excavation with specified backfill materials. Remove unstable materials unsuitable for supporting equipment or installation and replace with specified materials for a minimum of twelve (12) inches below invert of equipment or installation.
- C. Specified materials shall be utilized for backfilling, in not more than six (6) inch layers and tamped until the installation has cover of not less than the adjacent grade and not more than two (2) inches above same. Remove sheeting and cross-bracing during backfilling wherever such

removal would not endanger the work or other property. Equalize backfilling operation to avoid shifting of materials and equipment installed. Compaction of backfill materials shall be at least equal to surrounding undisturbed material. Backfill trenches with concrete where excavations pass within 18" of footings or other utility lines. Do not settle backfill with water. Conform to compaction requirements and methods specified elsewhere.

3.10 TESTS AND CERTIFICATIONS

- A. Upon completion of the electrical work and prior to final inspection, conduct an operating test in the presence of the Owner and the Architect/Engineer or his designated representative.
- B. The installation shall be demonstrated to operate in accordance with the Contract Documents. Any material or workmanship which does not meet with the approval of the Architect/Engineer shall be removed, repaired or replaced as directed without incurring additions to the Contract in time or cost. All electrical systems shall be tested for compliance with the specifications.
- C. Furnish all instructions, tools, test equipment and personnel required for the test. Have sufficient tools and personnel available to remove equipment covers, coverplates, etc., as required for review of internal wiring and proper inspection. Provide hand tools, flashlights, ladders, outlet testers, VOM, meters and keys required to access and observe system operation and characteristics. Turn circuits on and off as directed and demonstrate operation of equipment as directed.
- D. Contractor shall test all wiring and connections for continuity and grounds by megger testing. Upon indication of defective insulation, Contractor shall remove and replace the defective conductor and demonstrate by testing that the new conductor is acceptable. Record feeder load currents and line voltages measured at each transformer, switchboard and panelboard after installation of all equipment and lighting. Adjust transformer taps as required to provide optimum voltage levels. Adjust single phase load connections to balance feeder load and document on as-built drawings. Provide the Owner with full documentation of all testing for future reference.
- E. Refer to the individual specification sections and the electrical systems testing section of the specifications for specific testing requirements.
- F. The authorized manufacturer's service representative shall review systems and equipment for correct operation, conformance with specification requirements and manufacturer's requirements and submit certification indicating above mentioned conformances for the following systems:
 - 1. Life Safety System.
 - 2. Interfaces to Mechanical & Building Systems.

3.11 DEMONSTRATION AND INSTRUCTION

- A. Present to the Owner and the Architect/Engineer or his designated representative a physical demonstration and oral instructions for proper operation and maintenance of each of the electrical equipment and systems installed. Authorized manufacturer's representatives familiar with the specified equipment shall conduct training for the following systems:
 - 1. Life Safety System.

2. Interfaces to Mechanical & Building Systems.

3.12 WARRANTY

- A. All systems and components shall be provided with a minimum one-year warranty from the time of final acceptance. The warranty shall cover all defects in materials, design and workmanship. During this warranty period, all defects in materials and workmanship shall be corrected without incurring additions to the Contract. The correction shall include removing the defective part(s), replacing and installing the new parts (including shipping and handling), all required cutting, patching, repainting, or other work involved, including repair or restoration of any damaged sections or parts of the premises resulting from any fault included in the warranty, entirely at the expense of the Contractor.
- B. In addition to this general warranty, present to the Architect any other guarantees or warranties from equipment or system manufacturers. These supplemental guarantees or warranties shall not invalidate the general warranty.

3.13 FIRESTOPPING

- A. Apply Firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

END OF SECTION 26 05 00

SECTION 26 05 19 - 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.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Conductors shall be copper: Comply with NEMA WC 70oAll wire and cable and associated connectors shall be UL listed and shall bear the UL label.
- B. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the exterior at maximum 24 inch intervals.
- C. Control conductors for use on 120 volt control wiring shall be Type THHN/THWN, sized to avoid excessive voltage drop.
- D. Prefabricated cable assemblies
 - 1. Control conductors for use on 120 volt control wiring shall be Type THHN/THWN, sized to avoid excessive voltage drop.
- E. Connectors
 - 1. Terminations and connections shall be made with UL listed connectors applied per manufacturer's recommendations
 - 2. Connections shall be factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated drawings.
 - 3. Connections of special system conductors shall be made via dedicated terminal strips labeled to indicate wire number and system type. Wire nut connections in system junction box are not acceptable.

2.2 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. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Southwire Company.

5. Rome Cable Corporation
6. Carol Cable
7. AFC Cable Systems Inc.
8. Cerro Wire, LLC
9. Triangle Wire & Cable, Inc.
10. The Okonite Company

- B. Aluminum and Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- D. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.3 SIGNAL CABLE PRODUCTS

- 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. Belden.
 2. Dekoron.
 3. Continental
 4. West Penn.

2.4 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. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.
 5. AMP/Tyco Electronics Corp.
 6. Burndy
 7. Eagle Connector Corporation
 8. Thomas & Betts Corporation
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.5 WIRE MANAGEMENT PRODUCTS

- 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. Panduit Corporation.
 2. Wieland Inc.

3. AMP/Tyco Electronics Corp.
4. Thomas & Betts Corporation

2.6 WIRE PULLING LUBRICATION PRODUCTS

- 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. Ideal Industries Inc. – Yellow 77
 2. Burndy - Silikon
 3. Electro Compound Co. – YER EAS

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway or type XHHW, single conductors in raceway.
- B. Feeders: Type THHN-THWN, single conductors in raceway.
- C. Branch Circuits Type THHN-THWN, single conductors in raceway.
- D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.
- E. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- F. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. All conductors shall be installed in conduit, unless noted otherwise. All conductors shall be pulled in at the same time. No conductors shall be pulled into the conduit until the conduit system is complete and plaster/drywall construction has dried. Clean, swab and evacuate conduit system before pulling in conductors. Do not exceed the manufacturer's maximum pulling tension.
- B. Conductors shall be continuous from outlet to outlet and from outlet to junction box or pull box. All splices and joints shall be carefully and securely made to be mechanically and electrically solid with proper U. L. Listed connectors. Where connection is made to any terminals of more than 30

amperes capacity and where conductors larger than No. 10 are connected to any terminal, copper terminal lugs shall be secured to the conductors. Where multiple connections are made to the same terminal, individual lugs for each conductor shall be used.

- C. Each conduit shall have a minimum of three (3) conductors pulled in unless that particular conduit is noted as being for systems other than electrical circuitry and/or future use or unless noted otherwise. Grounding conductors are not shown in wire count, but are required from circuit origin to last device.
- D. Branch circuit conductors shall not be smaller than No. 12 and where the home run from panel to first device exceeds 60'-0", the conductors from home run outlet to panel shall be No. 10 minimum.
- E. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- F. Branch circuit wiring which supplies more than one light fixture through wireway of other fixtures shall be rated for use at 105 degrees C.
- G. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- H. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- J. Maintain phase rotation established at service entrance point throughout entire project.

3.4 CONTROL WIRING

- A. Control wiring is defined as the wiring that provides connections between control circuit elements and does not provide the power circuit.
- B. Generally, control wiring is specified in other divisions; however, where a control device such as a push-button, thermostat, fire stat, etc. is to be installed in the power circuit, these devices shall be received, stored, and installed as part of the work of this Division.
- C. Control wiring and conduit for control wiring shown on the electrical drawings shall be provided regardless of its function.

3.5 WIRE MANAGEMENT

- A. Power and control wiring within all special system cabinets and enclosures, and within switchboards and electrical equipment shall be bundled or routed within slotted wiring duct in a workmanlike manner.
- B. Any knockout, cutout or slot containing wiring shall be fitted with bushing or continuous grommet strip to avoid fraying or abrasion.

- C. Train and lace all conductors within panelboard or control enclosures with cable ties or spiral wrapping.
- D. Spare conductors installed shall be identified and capped.

3.6 CONNECTIONS

- A. All connectors shall be UL listed and shall be utilized in full accordance with manufacturer's requirements.
- B. Termination lugs shall be applied to all single cables #8 and larger, and shall be compression type fittings. The use of mechanical type lugs, kerneys, or other pressure type connections will not be permitted.
- C. All compression connections shall be long barrel type installed using hydraulic tools designed for the purpose.
- D. 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.
- E. Insulated spring steel wire nut connectors shall be used for branch circuit connections of #10 and smaller conductors. Connections of #8 and larger sizes shall be made with compression type connections with insulated covers. Where exposed to moisture or corrosion spring steel wire nut connectors shall be silicone filled.
- F. Control and special system riser and junction boxes shall be fitted with terminal strips and all conductors shall be labeled per system requirements. The installation of wire nuts in special system riser and junction boxes is not acceptable.
- G. Splices shall be made only where specifically approved by the Engineer. Conductors shall be continuous from origin to first outlet box or manhole. Splices made exterior to the structure, or below grade, shall be compression type connections with insulated, waterproof covers. Submit splicing requests for review and approval prior to installation.
- H. 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 for aluminum conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

1. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

- A. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: 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, and 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 wide and 1/16 inch thick.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 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, 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.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad, sectional type; 3/4 inch in diameter by 10 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 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 and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- 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 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, non-shrink 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.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. 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.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. 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 and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- C. 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.
- D. 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.
- E. 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 (18 m) apart.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, 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.

- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
 - 2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 - 3. Manhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 - 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.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

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.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. 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. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. 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 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.; a division of Cooper Industries.
 - 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: Threaded steel.

2.2 SEISMIC SUPPORTS AND RESTRAINTS

- A. The Division 26 Contractor shall be responsible for the design and installation of seismic restraints for the anchorage of all electrical equipment and conduit systems to the main structural system. Anchorage shall be designed for lateral forces in accordance with local Standard Building Code.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized 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 single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. 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.
- D. Mounting and Anchorage of Surface-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 New Concrete: Bolt to concrete inserts.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 4. To Light Steel: Sheet metal screws.
 - 5. Items Mounted 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 substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- 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. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

- A. Product Data: floor boxes, hinged-cover enclosures, and cabinets.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- 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. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
1. Comply with NEMA RN 1.
 2. Coating Thickness: 0.040 inch, minimum.
- D. EMT: ANSI C80.3.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. 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.
1. Fittings for EMT: Steel, set-screw or compression type.
- H. Joint Compound for Rigid Steel Conduit 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 NONMETALLIC CONDUIT AND TUBING

- 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.; Anaconda Metal Hose.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

- C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 SURFACE RACEWAYS

- A. Surface Nonmetallic Raceways: One-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
 - 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. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

2.4 OUTLET 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Hoffman.
 - 4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 5. O-Z/Gedney; a unit of General Signal.
 - 6. RACO; a Hubbell Company.
 - 7. Scott Fetzer Co.; Adalet Division.
 - 8. Spring City Electrical Manufacturing Company.
 - 9. Thomas & Betts Corporation.
 - 10. Walker Systems, Inc.; Wiremold Company (The).
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.
- F. Nonmetallic Floor Boxes: Nonadjustable, round.
- G. Outlet boxes and covers shall be of such form and dimensions as to be adapted to their specified usage, locations, size and quantity of conduit, and size and quantity of conductors entering the boxes.

- H. Outlet boxes for flush mounted light fixtures shall be four inch square boxes 1 ½" deep, with blank cover, installed adjacent to fixture served. Connection to fixture shall be with flexible steel conduit and fixture wire.
- I. Flush ceiling outlets for surface or pendant mounted lighting fixtures shall be one-piece 4" square or octagonal pressed steel boxes, minimum two (2) inch depth.
- J. Boxes for devices in unfinished masonry walls or stud walls shall be 4" square boxes with a square cornered tile wall cover (plaster ring), set flush with masonry or drywall construction. Where only one conduit enters box or one wiring device is provided, 2 ¾" deep box may be used. Outlet boxes for dimmers, GFI outlets, and all other conditions shall be full depth. Use multi-gang boxes where more than one device is mounted together under a common cover plate. Do not use sectional switch boxes.
- K. Boxes in concrete ceiling slab shall be octagonal, concrete-tight, two (2) inch deep concrete boxes. Welded boxes are not acceptable.
- L. All outlet boxes in plaster, drywall, stucco or masonry walls or ceiling shall be provided with plaster rings.
- M. Junction boxes and all outlets not indicated as containing wiring devices or lighting fixtures shall have covers. Covers for outlets in walls shall be as specified for wall switches and receptacles.
- N. Outlet boxes exposed to the weather, under raised floor, used in exterior wiring system and outlet boxes for vapor-tight lighting fixtures and devices shall be cast corrosion-resistant type.
- O. In special "Fire Rated" partitions, outlets shall comply with ASTM No. E119 and maintain fire barrier ratings.
- P. Utility (handy) boxes with matching covers may be used in mechanical and electrical spaces for switches and 15A/120V receptacles.
- Q. Where special purpose devices are utilized and require larger outlet box than specified herein, provide outlet box suitable for specific device. These outlet boxes shall be of the same type as specified herein for the installation required. Coordinate requirements prior to rough-in installation.

2.5 JUNCTION AND PULL 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Hoffman.
 - 4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 5. O-Z/Gedney; a unit of General Signal.
 - 6. RACO; a Hubbell Company.
 - 7. Scott Fetzer Co.; Adalet Division.

8. Spring City Electrical Manufacturing Company.
 9. Thomas & Betts Corporation.
 10. Walker Systems, Inc.; Wiremold Company (The).
- B. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- C. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- D. Dimensions of pull boxes and junction boxes shall not be less than those dimensions required by the National Electrical Code (NEC) for the number, size and position of conductors and raceway entering the box. Only a single extension ring shall be permitted on a box to increase the volume.
- E. Pull boxes required in finished spaces shall be installed out of sight lines and located per Architect's direction. Box shall be flush-mounted cabinets provided with trim, hinged door and flush latch and lock to match panel trim for flush mounted electrical panelboard.
- F. Pull boxes for installation of vertical riser conductors shall be provided with suitable supports for all conductors as required by the NEC.
- G. Pull boxes for horizontal feeders containing more than one feeder shall be compartmented by barriers (or feeder conductors shall be fire-taped) and provided with minimum 1 5/8" x 1 5/8" fiberglass channel strut (removable) for support of conductors. Wood supports within pull boxes are not acceptable.
- H. Provide box covers for all junction and pull boxes of same materials and construction as box. Identify feeder or branch circuit conductors contained within on outside of cover for surface mounted boxes and within cover on flush mounted boxes.

2.6 CONDUIT BODIES 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. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric.
 3. Hoffman.
 4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 5. O-Z/Gedney; a unit of General Signal.
 6. RACO; a Hubbell Company.
 7. Scott Fetzer Co.; Adalet Division.
 8. Spring City Electrical Manufacturing Company.
 9. Thomas & Betts Corporation.
 10. Walker Systems, Inc.; Wiremold Company (The)
- B. Conduit bodies and fittings shall be NEMA FB-1 zinc coated steel or malleable iron, taper threaded type, of material matching conduit type with gasketed cover containing captive screws.

2.7 WIRING TROUGH

- 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 Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric.
 3. Hoffman.
 4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 5. O-Z/Gedney; a unit of General Signal.
 6. RACO; a Hubbell Company.
 7. Scott Fetzer Co.; Adalet Division.
 8. Spring City Electrical Manufacturing Company.
 9. Thomas & Betts Corporation.
 10. Walker Systems, Inc.; Wiremold Company (The).
- B. Wiring trough shall be NEMA 1, unless noted otherwise, hinged cover with captive screws, gray enamel finished inside and outside, 16 or 14 gauge steel as per NEC requirements. Size of trough based on NEC requirements.

2.8 PULL BOXES AND ENCLOSURES

- 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 Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. EGS/Appleton Electric.
 3. Hoffman.
 4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 5. O-Z/Gedney; a unit of General Signal.
 6. RACO; a Hubbell Company.
 7. Scott Fetzer Co.; Adalet Division.
 8. Spring City Electrical Manufacturing Company.
 9. Thomas & Betts Corporation.
 10. Walker Systems, Inc.; Wiremold Company (The)
- B. Pull boxes for feeder and power conductors shall be NEMA 250, Type 1 with 14 or 12 gauge galvanized steel bodies and 12 or 10 gauge galvanized steel screw covers. Seams shall be continuously welded and ground smooth. Cover screws shall be captive, stainless steel type. Provide oil-resistant gasket and adhesive. Size pullboxes as specified.
- C. Hinged door in front cover with flush latch and concealed hinge.
- D. Key latch to match panelboards.
- E. Metal barriers to separate wiring of different systems and voltage.
- F. Accessory feet where required for freestanding equipment.

2.9 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Exterior pull boxes shall be Quazite "PC" style gasketed boxes, resistant to sunlight exposure, weathering and chemicals, with solid base, penta-head security bolts, heavy duty rated cover with logo to suit purpose, with compressive strength of 11,000 psi, or approved equal. Size shall be minimum 12"w x 18"d x 12"h unless noted otherwise. Set assembly at final finished grade elevation.
- B. Exterior handholes shall be Quazite "PG" style stackable service box assemblies resistant to sunlight exposure, weathering and chemicals, with solid base, penta-head security bolts, heavy duty rated cover with logo to suit purpose, with compressive strength of 11,000 psi, or approved equal. Size shall be minimum 24"w x 36"d x 18"h unless noted otherwise. Provide extensions as required to bring assembly to final finished grade elevation.
- C. 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. Quazite
 - b. Nelson
 - c. Killark
 - d. Associated Plastics
 - e. Armorcast Products Company.
 - f. Carson Industries LLC.
 - g. Christy Concrete Products.
 - h. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
 - 5. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

4. Damp or Wet Locations: IMC.
 5. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
- E. Do not install aluminum conduits in contact with concrete.

3.2 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. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- E. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- F. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- G. Install pull wires 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.
- H. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.

3. 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.
- I. 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 otherwise required by NFPA 70.

3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a 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, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.

3.4 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.

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 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.

1.3 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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 FLOOR MARKING TAPE

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.2 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.3 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.

2.4 INSTRUCTION SIGNS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Indoor Equipment - Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Outdoor Equipment - Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 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.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. 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. 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.
- G. 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.
- H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for service, feeder, and branch-circuit conductors.
 - a. Color shall be factory applied.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral White
 - 5) Ground Green
 - 6) IG Neutral White with Green Stripe
 - 7) IG Ground Green with White Stripe
- B. Install instructional sign including the color-code for grounded conductors using adhesive-film-type labels.
- C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal 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 the Operation and Maintenance Manual.
- D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- E. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For 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. Controls with external control power connections.
- G. Operating Instruction Signs: 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.
- H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Enclosed switches.
 - f. Enclosed circuit breakers.
 - g. Variable-speed controllers.
 - h. Push-button stations.
 - i. Contactors.
 - j. Remote-controlled switches, dimmer modules, and control devices.
 - k. Battery-inverter units.

END OF SECTION 26 05 53

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.

1.2 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

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.

1.5 COORDINATION

- 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 system, and partition assemblies.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Provide the product indicated in the drawings.
- B. Description: UL listed, solid state, normally open, isolated relay contacts rated for 1 amp @ 30VAC/VDC, to operate connected relay, contactor coils, or microprocessor input.
 - 1. Light-Level Monitoring Range: 1 to 15 fc with an adjustment for turn-on and turn-off levels within that range.
 - 2. Time Delay: 8-second minimum, to prevent false operation.

3. Mounting: ½" threaded-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

- A. Provide the product indicated in the drawings.
- B. Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit (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 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 (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
 1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. 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.

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.

3.3 WIRING INSTALLATION

- A. Wiring Method: Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-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.
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

- A. 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.

END OF SECTION 26 09 23

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge protective device.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards 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."

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 7. Include wiring diagrams for power, signal, and control wiring.
- C. Field Quality-Control Reports:
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.
- D. Operation and Maintenance Data: For panelboards 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. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NECA 407.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations:

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 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. Keys: Two spares for each type of panelboard cabinet lock.
 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Surface-mounted cabinets.
1. Rated for environmental conditions at installed location.

- a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Width: Single-row / Column Width Style as available per panelboard application.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
7. Directory Card: Inside panelboard door, mounted in transparent card holder
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
 1. Material: Tin-platted aluminum.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit. Pow-R-line Type PRL3a, 800A enclosure (28" wide x 5.75" deep).
 2. Siemens Energy & Automation, Inc. Type P2 (20" wide x 5.75" deep)

3. Square D; a brand of Schneider Electric. I-Line Type HCN (26" wide x 6.5" deep).
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- E. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit
 2. Siemens Energy & Automation, Inc.
 3. Square D; a brand of Schneider Electric
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - a. Instantaneous trip.
 2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.

- b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
- d. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
- e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407.
- B. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install overcurrent protective devices and controllers not already factory installed.
- E. Install filler plates in unused spaces.
- F. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components.
- B. Panelboard Nameplates: Label each panelboard with a nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, and feeders..
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared 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 panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments and 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. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 24 16

SECTION 26 27 13 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes equipment for electricity metering by Owner.

1.2 DEFINITIONS

- A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.
- B. PC: Personal computer.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

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.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

- 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. E-Mon; a division of Hunt Power.

2. National Meter Industries.
3. Osaki Meter Sales, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
3. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
 - a. Type: Solid core.

C. Kilowatt-hour Meter: Electronic single- and three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in other divisions.

3.3 FIELD QUALITY CONTROL

- A. 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.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.

4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
- C. Electricity metering will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 26 27 13

SECTION 26 27 26 - 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. Isolated-ground receptacles.
3. Snap switches.
4. Communications outlets.
5. Floor service outlets and multi-outlet assemblies.
6. Chime with Pushbutton.
7. Multi-outlet Assemblies.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- 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.

PART 2 - PRODUCTS

2.1 STRAIGHT BLADE RECEPTACLES

- A. Duplex Convenience Receptacles, 125 V, 20 A: Duplex receptacles shall be heavy-duty specification grade, plastic base, nylon face, two-pole, three wire, self-grounding, back/side wired, 125 volts AC and NEMA 5-20R (20A) rating. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
- B. Simplex Convenience Receptacles, 125 V, 20 A: Simplex receptacles shall be heavy-duty specification grade, plastic base, nylon face, two-pole, three wire, self-grounding, back/side wired, 125 volts AC and NEMA 5-20R (20A) rating. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
- C. Special Receptacles: Special purpose outlets shall be heavy-duty specification grade, plastic base, nylon face, poles as noted, wires as noted, grounding type, back/side wired, with voltage and capacity rating noted. Conform to NEMA configuration requirements.
- D. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Isolated ground duplex receptacles shall be orange heavy-duty specification grade, plastic base, nylon face, two-pole, three wire, self-grounding, back/side wired, 125 volts AC and NEMA 5-20R (20A) rating. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Description: Straight blade; 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.

2.2 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Ground fault circuit interrupting (GFCI) duplex receptacles shall be heavy-duty, industrial specification grade, plastic base, nylon face, two-pole, three wire, supplied with pre-stripped wire leads, feed-through protection, 125 volts AC and NEMA 5-20R (20A) rating. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Weatherproof Duplex Receptacles: Exterior flush mounted duplex outlets shall be GFCI heavy-duty, industrial specification grade, plastic base, nylon face, two-pole, three wire, supplied with pre-stripped wire leads, feed-through protection, 125 volts AC and NEMA 5-20R (20A) recessed mounted in TayMac model Masque 72206 or approved equal gasketed enclosure. Unit assembly shall protrude no more than 1/2" and shall be rainproof in use per NEC 410-57. Provide color as specified by the Architect.

2.3 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.
- B. 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. Arrow Hart.
 2. Eagle.
 3. Hubbell.
 4. Leviton.
 5. Pass & Seymour.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. General Description: Wall switches shall be Institutional, heavy-duty specification grade, plastic body, nylon or lexan toggle, totally enclosed base & cover, quiet type, self-grounding, back wired, 277/120 volts AC and 20A rating:
- C. Flush motor switches shall have a red pilot light and overload protection for actual fractional horsepower motors furnished.

2.5 COMMUNICATIONS OUTLETS

- A. Telephone and Data Outlet:
1. Description: Single RJ-45 jack for terminating 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.
- B. Combination TV and Telephone Outlet:
1. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.6 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material: Smooth, high-impact thermoplastic.
 3. Material for Masonry Wall: Jumbo type, smooth, high-impact thermoplastic.
 4. Cover plates for flush mounted GFCI devices shall be premarked "GFCI PROTECTED"
 5. Cover plates for flush mounted IG devices shall be pre-marked "ISOLATED GROUND".
 6. Telephone/data outlet cover plates shall be the same finish as above and have two (2) modular jack openings with blank fillers as required.

2.7 TELLER SWITCH WITH PILOT LIGHT

- A. Commercial Grade Pilot AC combination switch toggle.
- B. Color: White.
- C. 15Amp
- D. 120 Volt.
- E. Neon Pilot.
- F. Steel warp material.

2.8 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, solid brass with satin finish.
- D. Power Receptacle: Coordinate with power plan for configuration.
- E. Voice and Data Communication Outlet: Coordinate with power plan for configuration.
- F. 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. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Steel City
 - 3. Walker.

2.9 CHIME WITH PUSHBUTTON

- A. General
 - 1. Pushbutton shall be 13/16" round, unlighted and white in color. Mount pushbutton 48" above finished floor
 - 2. Chime shall be recessed, electronic with flush mounted white louvered grille. Faceplate shall be able to be field painted. Provide 2-3/4" deep back box. Cover shall be 6-11/16" wide by 8-5/8" high. Cutout shall be 5-1/4" wide by 7-1/4" high.
 - 3. Provide low voltage wired transformer compatible with chime. Transformer shall be located in recessed junction box adjacent to chime.
- B. 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. Pushbutton: NUTONE #PB18WHCL
 - 2. Chime: NUTONE #LA174WH
 - 3. Transformer: NUTONE #C915 16 VOLT 10VA
 - 4. Doorbell Push Button cover plate: 2159W-BOX WALPLAT 1GNG

2.10 MULTIOUTLET ASSEMBLIES

- 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. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold Company (The).
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: PVC.
- D. Wire: No. 12 AWG.

2.11 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. 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.
- C. 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.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted provided the outlet box is large enough.

D. 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 the last possible moment.
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.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. 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. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 26 27 26

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nonfusible switches.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 COORDINATION

- A. Coordinate layout and installation of switches, with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 NONFUSIBLE SWITCHES

- A. 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. 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; labeled for copper and aluminum neutral conductors.

3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with 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 individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Locate disconnect switches to provide working clearance and full accessibility as required by the NEC.
- C. Unless indicated otherwise on the drawings, locate disconnect switches adjacent to equipment served.
- D. Provide power wiring to and install all disconnect switches and extend feeders to motors or other loads, unless integrally factory mounted on a piece of equipment.
- E. Provide power wiring to all roof mounted equipment via roof curb openings provided. Do not penetrate roof membrane with conduit stub ups.
- F. Coordinate exact location of motor termination boxes with raceway rough-in provisions to insure correct installation.
- G. Connect all heating and air conditioning equipment and have this equipment complete and ready for operation. Contractor shall be responsible for checking equipment manufacturer submittal data to obtain exact location of all electrical connections for equipment before installation.
- H. A short section of liquid-tight metallic flexible conduit shall be used at each motor connection.

- I. The Division 26 Contractor shall be responsible for the design and installation of seismic restraints for the anchorage of all electrical equipment and conduit systems to the main structural system. Anchorage shall be designed for lateral forces in accordance with local Standard Building Code.
- J. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- K. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, and feeders..
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 28 16

SECTION 26 36 00 – TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual transfer switch.

1.2 DEFINITIONS

A. MTS: Manual transfer switch.

1.3 COORDINATION

- A. Equipment shall be furnished by PNC. Contractor shall deliver, install and test the manual transfer switches as specified herein and in accordance with the drawings.

PART 2 - PRODUCTS

2.1 MANUAL TRANSFER SWITCH

- A. Manufacturers: Subject to compliance with requirements, ESL Power Systems shall be the sole manufacturer for equipment shown.
- B. Quality Assurance:
1. Manual transfer switch shall be UL listed and labeled under the UL 1008 standard.
 2. Manual transfer switch shall be special seismic certified by OSHPD exclusively on the basis of approved shake table testing, and also certified to IBC 2015. Minimum IBC 2015 design parameters shall be as follows: $I_p = 1.5$, $SDS = 2.0g$, $z/h = 1.0$.
 3. Manual transfer switch manufacturer shall provide a complete factory assembled, wired and tested manual transfer switch.
 4. Manual transfer switch manufacturer shall submit UL 1008 certification of authenticity.
 5. Manual transfer switch shall be factory Hi-pot tested for a period of not less than 60 seconds.
 6. Manual transfer switch installation shall meet all applicable NEC standards.
- C. Manual transfer switch shall consist of (2) two mechanically-interlocked molded case circuit breakers; kirk-locks are not acceptable, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.
- D. Manual transfer switch enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated galvalume steel. The main access shall be through an interlocked, hinged door

that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via a) drawn flange cable entry openings in the bottom of enclosure for wall mount units, or b) hinged lower door for pad mount units. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication; color shall be wrinkle gray RAL 7035.

- E. Number of male input cams shall not exceed the number as shown on the drawings and must be rated for the specified amperage.
- F. Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral if required. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. The neutral cam-style male connectors, if required, shall be factory wired to a power distribution block. None of the cam-style male connectors shall be accessible unless both molded case circuit breakers are in the "OFF" position and the main access door is open.
- G. A power distribution block shall be provided for load-side field wiring. The power distribution block shall be factory wired to the molded case circuit breakers.
- H. Molded case circuit breakers shall be UL Listed and the short circuit interrupt rating shall be a minimum of 35kAIC at 480VAC. Trip rating of the molded case circuit breakers shall be as shown on the drawings. One molded case circuit breaker shall be fed from utility power; the other molded case circuit breaker shall be fed from the cam-style male connectors to supply power from a portable generator. Both molded case circuit breakers shall include UL Listed door-mounted operating mechanisms (with provisions for a locking device), preventing the opening of the main access door unless both breakers are in the "OFF" position. Both molded case circuit breakers shall be mounted behind a deadfront panel. The load-side of the molded case circuit breakers shall not be energizable unless the main access door is closed and one of the molded case circuit breakers is in the "ON" position. The (2) molded case circuit breakers shall be safety interlocked by mechanical means to ensure that only one breaker can be closed at any given time.
- I. Manual transfer switch shall be suitable for use as service equipment in the USA as defined by the NEC.
- J. Manual transfer switch shall include permanently affixed operation instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive transfer switches and conduit pathways for compliance with 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. Manual transfer switch shall be installed as shown on the drawings and per the manufacturer's written instructions. In addition, the installation shall meet the requirements of local codes, the National Electrical Code and National Electrical Contractors Association's "Standard of Installation".
- B. Conduit entry into the manual transfer switch shall be by Contractor; Contractor shall furnish and install UL listed watertight conduit hubs, as manufactured by MYERS, T&B or other for each conduit entry on the manual transfer switch. The incoming hub size shall match the conduit size for feeders and ground as shown on the drawings. The outgoing hub size shall match the conduit size for loads and ground as shown on the drawings.
- C. Any conduit penetrations that are above live parts must be properly sealed to prevent moisture intrusion from the conduit. A UL Listed or Classified expanding foam sealant (such as Rainbow Quick Seal 79547), or other sealing product meeting local codes and NEC requirements should be used to seal the interior of the conduit around the cables. The product selected must be able to permanently seal around all wires and the conduit (common "Duct Seal" is not acceptable for this application). The sealing shall be done at the entry into the enclosure so the seal can be verified and inspected from inside the enclosure. Failure to seal may allow water to drip on live parts and will void warranty. Hubs shall be properly installed and tightened to maintain Type 3R integrity of the manual transfer switch enclosure.
- D. Contractor shall terminate feeder conductors, load conductors and ground per the manufacturer's instructions. All field wiring terminations shall be torqued as required per the instructions on the manual transfer switch's power distribution block, circuit breaker & ground lug.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Certify mounting and connections are complete and secure.
 - 2. Verify internal components and wiring are secure.
 - 3. Perform continuity check of all circuits.
 - 4. Perform 1,000 VDC megger test on feeder, load and ground cables.

5. Verify deadfront is secure.
6. With the manual transfer switch deadfront in place and the main access door closed and properly latched, actuate both Operator Mechanisms; verify only (1) breaker at a time can be turned to the "ON" position.
7. Confirm operation of the manual transfer switch ground receptacle by attaching a plug to the MTS ground receptacle and then verify that the plug is grounded to the facility ground.
8. Once utility power has been applied, confirm operation of the manual transfer switch by following directions on the main access door.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Manual transfer switch will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, and include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION 26 36 00

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

- 1.1 Lighting fixture package to be furnished by PNC through Villa Lighting or Laface-McGovern. Light fixture submittals are required to be submitted to the EOR for review when utilizing light fixtures supplied by PNC's lighting vendor.

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 the following types of LED luminaires:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

- B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.4 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: For luminaires, 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.

B. Sample warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Five percent of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: Five percent of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: Five percent of each type and rating installed. Furnish at least one of each type.

1.9 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.
- B. Store all materials in a closed building, in original packaging, and protect from damage and the elements.
- C. Decorative elements of fixtures shall be packed by the manufacturer separately from the housing of the fixture, stored at the job site and installed only after completion of plastering, ceiling tile work, painting and general cleanup in area.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

- C. Ambient Temperature: **5 to 104 deg F.**
 - 1. Relative Humidity: Zero to 95 percent.
- D. Altitude: Sea level to **1000 feet.**

2.2 LUMINAIRE REQUIREMENTS

- 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.
- B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- E. California Title 24 compliant.
- F. LED's shall be "Bin No. 1" quality.
- G. User-Replaceable Lamps:
 - 1. Bulb shape complying with ANSI C78.79.
 - 2. Lamp base complying with ANSI C81.61.
- H. CRI of minimum 80. CCT of 4100 K.
- I. L70 lamp life of 50,000 hours.
- J. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- K. Internal driver.
- L. Minimum allowable efficacy of 80 lm/W
- M. Drivers shall be solid state and accept 120 through 277 VAC at 60 Hz input.
- N. Luminaires shall have internal thermal protection.
- O. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are

designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

P. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated

Q. Luminaires shall not draw power in the off state. Luminaires with integral occupancy, motion, photo-controls, or individually addressable luminaires with external control and intelligence are exempt from this requirement. The power draw for such luminaires shall not exceed 0.5 watts when in the off state.

R. Luminaire manufacturers shall adhere to device manufacturer guidelines, certification programs, and test procedures for thermal management.

S. Luminaires shall be fully accessible from below ceiling plane for changing drivers, power supplies and arrays.

T. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

U. Standards:

1. ENERGY STAR certified.
2. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.
3. UL Listing: Listed for damp location.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

- E. Aluminum: ASTM B 209.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "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 luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.

3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

- 1.1 Lighting fixture package to be furnished by PNC through Villa Lighting or Laface-McGovern. Light fixture submittals are required to be submitted to the EOR for review when utilizing light fixtures supplied by PNC's lighting vendor.

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:
1. Emergency lighting units.
 2. Exit signs.
 3. Luminaire supports.

1.4 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
1. Include data on features, accessories, and finishes.
 2. Include physical description of the unit and dimensions.

3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and 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.

C. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: For luminaires, 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.
4. Provide seismic qualification certificate for each piece of equipment.

B. Sample Warranty: For manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: Five percent of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: Five percent of each type and rating installed. Furnish at least one of each type.
 - 3. Diffusers and Lenses: Five percent of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: Five percent of each type and rating installed. Furnish at least one of each type.

1.9 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.
- B. Store all materials in a closed building, in original packaging, and protect from damage and the elements

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- 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.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 - 1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. 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.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
 - 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire 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.
 - 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

7. 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 a flashing red LED.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

1. Emergency Luminaires: As indicated on Drawings, with the following additional features:
 - a. Nominal voltage: As indicated on drawings.
 - b. Internal emergency power unit.
 - c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
 - d. UL 94 flame rating as appropriate for the installed location.

B. Emergency Lighting Unit:

1. Emergency Lighting Unit: As indicated on drawings.
2. Nominal voltage: As indicated on drawings.
3. Wall mounted with universal junction box adaptor.
4. UV stable thermoplastic housing, rated for damp locations.
5. Two lamp heads.
6. Internal emergency power unit.

C. Remote Emergency Lighting Units:

1. Emergency Lighting Unit: As indicated on drawings.
2. Nominal voltage: As indicated on drawings.
3. Wall mounted with universal junction box adaptor.
4. UV stable thermoplastic housing, rated for damp locations.
5. One lamp head unless otherwise indicated on drawings.
6. External emergency power unit.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Nominal voltage: As indicated on drawings.
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Glass: Annealed crystal glass unless otherwise indicated.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.6 METAL FINISHES

- A. 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 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, **12 gage**.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
 - 1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect all luminaires. Replace lamps, emergency power units, batteries, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265213