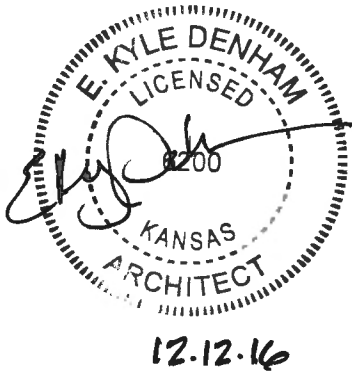


BUILDING 'C' RENOVATION

FOR

KMT WATERJET SYSTEMS, INC.

BAXTER SPRINGS, CHEROKEE COUNTY KANSAS



December 2016

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SECTION 02 41 00 DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Demolition:
 - 1. Perform all the site and building demolition as called for or indicated on the drawings and as required to complete the work.
 - 2. The Contractor shall exercise every possible care to avoid damage of existing paving, curbs and gutters, trees, buildings and other features to remain after the demolition process.
 - 3. The Contractor shall establish means as required for protection of adjacent features from effects of dust and debris in the areas of the demolition and construction process.
 - 4. If existing structures, equipment, and/or systems which are to remain are rendered unusable by negligence, the Contractor shall replace the same with items of equal quality at his expense.
 - 5. The site and adjacent areas shall be policed and debris from demolition removed daily.
 - 6. Barriers shall be erected in accordance with all local, state, and federal safety regulations for protection of personnel where demolition and construction is being carried on.
- B. Salvage:
 - 1. Owner to have first right of refusal of all salvageable materials. All salvageable materials not claimed by Owner, or not to be reused shall become the property of the Contractor, except as noted on the Drawings.
 - 2. Remove all refuse and waste to an approved disposal site.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 REMOVAL

- A. Remove all items indicated on Drawings and as required to prepare for the new construction.
 - 1. Haul away and dispose of removed materials at a disposal site approved by regulatory agencies.

3.02 PROPERTY PROTECTION

- A. Provide all shoring, bracing, temporary construction, and barricades which are necessary to support adjoining soil, streets, walks, buildings, and other features to remain.
- B. Protect demolition and storage area. Post with "No Trespassing" signs. Keep unauthorized persons out of demolition and storage areas.
- C. Protect adjacent buildings and property from damage. Repair damage occurring to adjacent buildings and property due to Contractor's operations without expense to the Owner.

END OF SECTION

DIVISION 3 CONCRETE
SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 WORK INCLUDED

- A. Furnish all material, equipment, transportation and facilities, and perform all labor necessary for the following:
 - 1. Cast-in-place concrete.
 - 2. Finish and curing of concrete.
 - 3. Concrete mix designs.
- B. Related Sections:
 - 1. Section 32 16 00 - Curb & Gutter, Sidewalks, and Exterior Concrete Slabs.
 - 2. Section 07 21 00 - Thermal Insulation: Perimeter Insulation.

1.03 TESTING

- A. The Contractor shall employ the services of a qualified testing agency and laboratory to perform testing of concrete as required in these Specifications.
- B. The Contractor shall give timely notice to the testing agency prior to ordering the delivery of any concrete so that the testing agency can schedule the presence of testing personnel for sampling and testing.

1.04 SUBMITTALS

- A. Submit two (2) copies of laboratory trial mix designs proposed in accordance with Method 1 ACI 301, or one (1) copy each of five (5) consecutive test results and the mix design used from a record of past performance in accordance with ACI 301 Method 2.
 - 1. Selection of Proportions: Proportions of ingredients for concrete mixes shall be determined and/or certified by an independent testing laboratory in accordance with the requirements of the ACI Standard "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE" (ACI 318).
 - 2. All concrete mix designs shall include the following information:
 - a. Proportions of cement, fine and coarse aggregates and water.
 - b. Water-cement ratio, design compressive strength, slump and air content.
 - c. Type of cement and aggregates.
 - d. Type and dosage of all admixtures.
 - e. Special requirements for pumping.
 - f. Range of ambient temperature and humidity for which the design is valid.
 - g. Any special characteristics of the mix which require precautions in the mixing, placing, or finishing techniques to achieve the finished product specified.
 - 3. The testing laboratory providing concrete mix designs shall be selected by the Contractor, and paid for by the Contractor.
- B. Submit manufacturer's data showing compliance with specifications for the following products:
 - 1. Curing compounds
 - 2. Admixtures
- C. Submit a sample ready-mixed concrete delivery ticket in accordance with requirements of ASTM C 94.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. All materials shall be so delivered, stored and handled, as to prevent the inclusion of foreign materials and damage of materials by water or breakage. All materials shall be clean and processed from reliable sources. Contractor (or supplier in the case of using ready-mixed concrete) shall submit to the Architect a mix

proportion certification for approval before placing of any concrete. Contractor shall acknowledge the requirement of the use of curing compound as specified and its availability before placing of any floor slabs.

- B. Portland Cement: Portland cement shall conform to the Standard Specifications of the ASTM C 150, Type 1, latest edition. Cement produced by the same mill shall be used throughout the project. One sack of cement shall be considered as one cubic foot of volume or 94 pounds by weight.
- C. Fine Aggregate (Sand): Fine aggregate shall consist of sand having clean, hard, durable, uncoated grains, free from deleterious substances and conforming to ASTM C 33.
- D. Coarse Aggregate: Coarse aggregate shall consist of crushed limestone, or other approved inert materials with similar characteristics having clean, hard, durable, uncoated particles, free from deleterious matter and conforming to ASTM C 33, Size 67.
- E. Mixing Water: Mixing water shall be clean and free from oil, acid, and injurious amounts of vegetable matter, alkalies, and other impurities. Preferably, City water shall be used for concrete mix.
- F. Air-Entraining Admixture: Master Builders MB-AE10 or approved equal, conforming to ASTM C 260. All exterior concrete subject to exposure shall be air-entrained. Total air content required shall be between five (5) percent and seven (7) percent.
- G. Water Reducing Admixture: Master Builders Pozzolite 322-N or approved equal containing no calcium chloride. (ASTM C 494 Type A) (See Cold Weather Requirements. For temperatures between 30 degrees and 40 degrees use Accelerating Pozzolite NC534. The use of calcium chloride in the concrete is prohibited.)

2.02 MIX PROPORTIONS

- A. Portland Cement: 5½ sacks per cubic yard (minimum) for all concrete.
- B. Pozzolite (Optional): 3 to 6 fluid ounces per 100 lbs. of cement.
- C. Flyash (Optional): Flyash can be used except for slabs.
- D. Water: as required not to exceed slump requirement.
- E. Strength:
 - 1. Floor Slabs: 4,000 psi @ 28 days.
 - 2. All other concrete: 3,000 psi at 28 days.
 - 3. For curb & gutter, sidewalks and for other exterior flatwork refer to Section 32 16 00.
- F. Moisture found in aggregates shall be taken into consideration. Moisture in the aggregate shall be measured in accordance with ASTM C 566. The methods of measuring concrete aggregates shall be such that the proportions can be accurately controlled and easily checked at any time during the work. Measurements and materials for ready mixed concrete shall conform with the Standard Specifications of the ASTM C 94, latest edition.

2.03 WORKABILITY

- A. The mixture shall produce a concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive spading or separation of materials. In no case shall more than one part of fine aggregate be used to one part of coarse aggregate nor shall amount of coarse aggregate be such as to produce harshness in placing, or honeycombing in the structure. The standard slump test (ASTM C 143) shall be used to check the workability of each batch of concrete. The maximum slump allowable shall be as indicated on the Drawings. The maximum slump allowable for pavement shall be 4 inches. The Architect may allow or order variations from this amount as required by specific conditions of the job.

2.04 MIXING

- A. Concrete shall be mixed in a truck mixer until there is a uniform distribution of materials. The entire contents of the drum shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer. The mixer shall be operated at not greater than twenty r.p.m. Mixing shall continue for at least one and one-half minutes after all the ingredients are in the mixer. The delivery ticket for each load of concrete shall state the proportions of each material in the mix for that load.

- B. Concrete transported in a truck mixer, agitator, or other transportation device, shall be discharged at the job and placed in its final position in the forms within one and one-half hours after the introduction of the mixing water to the cement and aggregate, or the cement to the aggregate, except that in hot weather or under other conditions contributing to quick stiffening of the concrete, the maximum allowable time may be reduced by the Architect.
- C. Retempering of concrete which has partially hardened, that is, remixing with or without additional aggregate, cement or water, will not be permitted.

2.05 REINFORCEMENT

- A. Reinforcing steel shall be manufactured from new billet steel of 60,000 psi yield strength and shall conform to ASTM A 615. Wire mesh fabric shall conform to ASTM A 185.

2.06 FORMS

- A. Forms shall be true and rigid and built to line, shape and grade shown on the plans. They shall be made of sound and reasonably smooth lumber, plywood, or steel. Joints shall be mortar tight and forms shall be tied and braced to prevent any bulging or deflection during concreting. Cut cleanouts at bottom as required for removal of sawdust and debris.
 - 1. Plywood: PS 1, sound, undamaged sheets with straight edges.
 - 2. Lumber: Construction grade.
 - 3. Steel: Minimum 16 gage sheet, well matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
 - 4. Carton Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete until initial set.
 - 5. Form Release Agent: Colorless mineral oil which will not stain concrete.
- B. All form ties shall have 3/4" cones with 1" break-back.
- C. Before reusing forms, or when using second-hand lumber for forms, they shall be cleaned and all nails removed therefrom. Immediately before erecting formwork, all forms shall be thoroughly cleaned of all dirt, debris and foreign matter, and a light coating of form release agent applied.
- D. Box out for all slots, chases, recesses or openings as shown on the Drawings and as required by the work of all other trades. Box out for all temporary openings such as pipe spaces, and build forms to seal up when and as required.
- E. Design, engineer, and construct forms, shores, bracing, and other temporary supports to support loads imposed during construction, in accordance with ACI 347. Design under the direct supervision of a licensed Professional Engineer experienced in design of this work.

2.07 INSULATION

- A. Refer to Section 07 21 00.

2.08 VAPOR BARRIER UNDER SLAB-ON-GRADE

- A. 10 mil thick polyethylene film, clear or black, with 12 inch minimum lap at adjoining edges.

2.09 WATERSTOP

- A. Ribbed PVC with center bulb as manufactured by Vinylex Corporation; Knoxville, TN (423) 690-2211, Greenstreak, St. Louis, MO (314) 225-9400, or BoMetals, Inc., Powder Springs, GA (770) 439-8577.
- B. Profile: 4 inch width, ribbed, with center bulb.

2.10 EPOXY BONDING AGENT (ASTM C 881)

- A. Concrese Liquid (LPL) by Master Builders Technologies; San Carlos, California (800) 227-8464.
- B. EVA-POX Epoxy Paste No. 22 by E-poxy Industries, Inc.; Ravena, New York (800) 833-3400.

- C. Uniweld by Permagile Industries, Inc.; Plainview, New York (800) 645-7546.
- D. Substitutions: Similar product by other manufacturers. Submit name, compressive strength and tensile strength for acceptance.

2.11 PREMOLDED JOINT FILLER

- A. Non-extruding resilient type conforming to ASTM D 1752, Type I or Type III. For sealant and backer material over premolded joint filler refer to Section 07 92 00.

2.12 CHEMICAL CURE FOR SLABS

- A. Non-residual compound designed and certified to be compatible with finish flooring:
 - 1. Dress & Seal by L&M Construction Chemicals, Inc.; Omaha, Nebraska (800) 362-3331.
 - 2. Kure-N-Seal by Sonneborn Building Products; Minneapolis, Minnesota (800) 433-9517.

2.13 MOISTURE CURE

- A. Water: Potable.
- B. Moisture-retaining Coverings: Burlap, cotton mats, or other moisture-retaining fabrics; AASHTO M 182, ASTM C 171, or AASHTO M 73. Provide burlap free of sizing. Rinse thoroughly in caustic soda to remove soluble substances and make burlap more absorbent.

2.14 WATERSTOP (SWELLABLE)

- A. Flexible butyl rubber and a swellable dry waterproofing compound that swells upon contact with water to form a long lasting compression seal in non-moving concrete joints. As manufactured by Carter-Waters or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify anchors, seats, plates, reinforcement, precast catch basins, floor drains and other items to be cast into concrete are accurately placed, held securely, and will not cause hardship in placing concrete.
- B. Refer to Drawings showing plumbing for location of precast catch basins and floor drains.

3.02 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Apply bonding agent in accordance with manufacturer's instructions. Do not apply bonding agent at slab-on-grade construction joints.

3.03 PLACING REINFORCEMENT

- A. Reinforcing bars shall be accurately placed and securely tied with No. 18 iron wire at all intersections. Bars and mesh shall be supported above subgrade on precast concrete blocks and above forms on steel chairs and spacers. Metal hangers shall be used for support of vertical reinforcing. Metal chairs, which are in contact with the exterior surface of the concrete, shall be galvanized. Layers of bars shall be separated by supporting bars with wire from formwork. The use of pebbles, pieces of broken stone or brick, metal pipe and wood blocks for support of bars shall not be permitted.
- B. Splicing and laps shall be as shown on Drawings.
- C. In slabs on grade and elevated slabs, position welded wire fabric or reinforcement bar 2" above bottom of slab. During concrete placement operations, assign one man to keep fabric properly positioned and during this time "he shall do nothing else". Reinforce such slabs with wire mesh fabric of the sizes indicated on the Drawings. For all exterior stoops, walks, curbs, and exterior slabs, refer to Drawings.
- D. All reinforcement shall be unpainted, uncoated, clean and free of rust or scale before being placed.
- E. Placement of reinforcing shall be approved by the Architect and/or Engineer before concrete is placed.

3.04 PREPARATION FOR PLACING CONCRETE

- A. Preparation: Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to assure a practically continuous flow of concrete at the delivery end without separation of the materials, and all of the details thereof shall be submitted to Architect for approval in advance of the use of such equipment. The use of gravity-flow or aluminum chutes or conveyors for transporting concrete horizontally will not be permitted. Where placing of structural concrete by pumping methods are required comply with ACI 304.2R "Placing Concrete By Pumping Methods".
- B. Inserts: Give the various trades and subcontractors ample notification and opportunity to install anchors, nailers, pipes, conduits, boxes, stair nosings, pipe bollards, inserts, thimbles, sleeves, frames, vents, wires, supports, or other items required to be built into the concrete by the provisions of the Drawings or of the Specifications governing the work of such trades and subcontractors, or as may be necessary for the proper execution of their work. Obtain suitable templates or instruction for the installation of such items as are not required to be actually placed in the forms by the affected trades or subcontractors themselves.
- C. Contractor shall provide access for delivery and provide sufficient equipment and manpower to rapidly place all concrete.
 - 1. All work shall be in accordance with ACI 304-83 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete".
 - 2. Formwork shall have been completed; snow, ice, water, and debris shall have been removed from within forms.
 - 3. Expansion joint material, anchors, and all embedded items shall have been positioned.
 - 4. Subgrades shall be sprinkled sufficiently to eliminate water loss from the concrete.

3.05 DEPOSITING CONCRETE

- A. General: Place concrete in reasonably uniform layers, approximately horizontal, 12 to 18 inches thick exercising care to avoid vertical joints or inclined planes. The piling up of concrete in the forms, in such manner as to cause the separation or loss of any of its ingredients, will not be permitted. Concrete which has partially set or hardened shall not, under any circumstances, be deposited in the work. Place concrete in the forms as nearly in its final position as is practical to avoid rehandling. Exercise special care to prevent splashing the forms or reinforcement with concrete. Remove any hardened or partially hardened concrete which has accumulated on the forms or reinforcement before the work proceeds. Do not place concrete on previously deposited concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the respective member or section, except as hereinafter specified. Do not permit concrete to drop freely any distance greater than four feet (4'-0"). Where longer drops are necessary use a chute, tremie, or other approved conveyance to assist the concrete into place without separation. Do not place directly into any excavations where water is standing. If the place of deposit cannot be successfully pumped dry, place through a tremie with its outlet end near the bottom of the place of deposit.
- B. Slump: Concrete shall not be placed when its plasticity, as measured by slump test, is outside the limits shown on the Drawings.
- C. Vibration: As soon as concrete is deposited, thoroughly agitate the same by means of mechanical vibrators and suitable hand tools, so manipulated as to work the mixture well into all parts and corners of the forms, and entirely around the reinforcement and inserts. Mechanical vibrators shall have a minimum frequency of 7000 revolutions per minute and shall be operated by competent workmen. Over-vibrating and use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at many points, from 18 to 30 inches apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation, generally from 5 to 15 seconds duration. A spare vibrator shall be kept on the job site during all concrete placing operations. Do not insert vibrator into lower courses that have begun to set. Avoid placing vibrator in contact with reinforcing steel.
- D. Concrete shall not be placed on frozen ground.

- E. Thoroughly wet all forms and contact surfaces before placing concrete. For pavement the base shall be thoroughly wetted prior to placing concrete and kept moist at all times during the placing operation. If a situation arises such that the base is allowed to dry out, it shall be rewetted before placement is allowed to continue.
- F. Conveying Concrete: Convey concrete from the mixer to the place of final deposit by methods which will prevent the separation or loss of the ingredients. Concrete to be conveyed by pumping will require approval of Architect for each class of concrete specified before being used.
- G. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during the depositing of concrete.

3.06 FINISHING

- A. For all surfaces covered in final construction or below grade, the ties shall be broken off and all voids shall be grouted.
- B. For vertical surfaces exposed to view all ties shall be broken off, all voids grouted, all fins, joints, ridges, and form defects carefully removed. Surfaces shall be rubbed with cement or abrasive bricks and water within 24 hours after removal of forms, and a general uniform appearance attained.
- C. Interior slabs shall be floated to a uniform level surface with a uniform slope to drains, as shown on the Drawings. Final finish for building floors shall be hard steel trowel finish giving a hard, dense, smooth surface. If sufficient fines cannot be worked up from base slab, the Contractor may apply a dry mix of cement and sand passing a No. 16 sieve and mixed in the ratio of 1:2½ by volume. Compact and work surface mix into base course. The surface mix shall never be added as a "drier" to absorb excess surface water.
- D. Monolithic Slab Finishes:
 - 1. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping, mortar setting beds for tile, or other bonded applied cementitious finish flooring material, and as otherwise indicated.
 - a. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 15 and floor levelness (Fl) of 13. Slope surfaces uniformly to drains where required.
 - b. After leveling, roughen surfaces before final set with stiff brushes, brooms or rakes.
 - 2. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified.
 - a. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating.
 - b. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of Ff 18 - Fl 15. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
 - 3. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed to view and surfaces to be covered with resilient flooring, carpet, thin set ceramic tile, paint, or other thin film finish coating system.
 - a. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 20 - Fl 17.
 - 4. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified; then immediately follow with slightly scarifying surface by fine brooming.
 - 5. Nonslip Broom Finish: Apply nonslip broom finish to exterior concrete sidewalks, stairs, landings, ramps, and elsewhere as indicated.

- a. Immediately after light steel trowel finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- E. As soon as floor will bear weight after final troweling, sweep clean of any dirt and soil.
 - 1. Apply two (2) coats of chemical curing compound in strict accordance with manufacturer's instructions, except where finish floor will be thin-set terrazzo or seamless troweled flooring.
 - 2. Preferred cure for floors where terrazzo finish or seamless troweled flooring will be applied is moisture cure. Cover floor with burlap or cotton mats and maintain continuously moist by misting spray for a minimum of seven days after concrete is placed.

3.07 CURING AND REMOVAL OF FORMS

- A. After placement, exposed concrete not covered by forms shall be moist cured. After forms are removed, exposed concrete surfaces shall be moist cured for an additional time to total seven (7) days since the placement of the concrete.
- B. Concrete shall be cured at a temperature within the range of 50°F., to 100°F. For cold weather and hot weather requirements, see articles so titled below.
- C. Forms shall remain undisturbed until the concrete has gained sufficient strength to sustain its own weight and any temporary or permanent load that may be placed on it during the building of the structure. For pavement, forms may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations, but not sooner than 24 hours from cessation of concrete placement. In no case shall forms for other concrete items be removed in less than three (3) days after placing concrete.

3.08 REQUIREMENTS FOR COLD WEATHER

- A. No concrete shall be placed on iced or frozen subgrade. No concreting will be permitted in temperatures below 32°F. Do not use frozen materials containing ice or snow. Ascertain that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow, and ice and temperature of these materials is above 32°F before placing concrete.
- B. Comply with the following for minimum temperature of concrete delivered to jobsite:
 - 1. Air temperature 32-45°F: Concrete temperature 60°F minimum.
 - 2. Maximum concrete temperature: Not to exceed the minimum required temperature by more than 10°F.
- C. Combine water heated to above 100°F with aggregates before cement is added. Do not add cement to water or aggregates having temperature greater than 100°F.
- D. When temperatures of 40°F or lower occur during the placing and curing of concrete, maintain temperature of concrete at not less than 55°F for at least three (3) days.
 - 1. Make arrangements before placement to maintain required temperature without damage from excessive heat.
 - 2. Do not use combustion heaters during first 48 hours without precautions to prevent exposure of concrete to exhaust gases containing carbon dioxide and carbon monoxide.
 - 3. Provide temporary housings or coverings including tarpaulins or plastic film. Keep protection in place and intact at least 24 hours after artificial heat is discontinued.
 - 4. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
- E. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306R and as herein specified.
- F. No admixtures shall be used except with approval of the Architect. For temperatures between 32°F and 40°F, use Master Builders Accelerating Pozzolite NC 534.
 - 1. Mix proportions shall be as follows:
 - a. 32-40°F 24-32 oz. per 100 lbs. of cement

- G. The use of salts, chemicals, or other foreign materials in the concrete mix to lower the freezing point is prohibited.

3.09 REQUIREMENTS FOR HOT WEATHER

- A. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305R and as herein specified.
- B. Temperature of concrete at time of placing: Not to exceed 90°F. Maintain an accurate reading thermometer at the job site to check temperature of concrete. Reject concrete before placing if temperature of concrete exceeds 90°F.
- C. Execute special precautions to protect fresh concrete before and during finishing when the rate of evaporation of surface moisture from concrete exceeds 0.2 pounds per square foot per hour. Determine rate of evaporation in accordance with ACI 305R. Provide special precautions as required:
 - 1. Cool ingredients before mixing to reduce concrete temperature at time of placement. Mixing water may be chilled, or chopped ice may be used to control the temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.
 - 2. Dampen subgrade and forms.
 - 3. Cover reinforcing steel with water-soaked burlap so the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

3.10 EXTERIOR AND INTERIOR CONTROL JOINTS

- A. Saw concrete slab within 12 hours after placing. Saw joints shall be 1/5 of the total slab thickness in depth for building floor slabs.
- B. Joints for slabs shall be where shown on Drawings.

3.11 TESTING

- A. Testing shall include unconfined compression test of molded concrete cylinders, slump tests, air content tests (where air-entrainment is required) and fresh concrete temperature tests.
 - 1. Testing for Building: Concrete shall be sampled, cured and tested for compressive strength in accordance with ASTM C 31, ASTM C 39 AND ASTM C 172. Compressive tests shall be prepared in sets of three (3) cylinders for each test. Specimens for each set shall be obtained at regularly spaced intervals during discharge of the middle half of a load from a stationary mixer or truck. A minimum of one (1) set shall be taken for each 1000 square feet of surface for slabs or walls. Not less than one (1) set shall be taken per 40 cubic yards of concrete nor less than one (1) set shall be taken for each foundation or structure except when placing a number of items each smaller than 10 cubic yards, in this case one (1) set per 10 cubic yards shall suffice.
 - 2. All cylinders shall be stored per ASTM C31.
 - 3. Test for Slump, Air Content and Temperature:
 - a. Slump test shall be taken for each set of test cylinders as well as from each load from a stationary mixer or truck to test consistency of concrete. Tests shall be in accordance with ASTM C 143 and ASTM C 172.
 - b. The acceptance test for air content of air-entrained concrete shall be made regularly in accordance with ASTM C 173.
 - c. The temperature of the fresh concrete from each set of cylinders shall be recorded.
 - 4. Test Cylinder Identification: Test cylinder sets shall be dated and numbered consecutively. Each cylinder of each set shall be given an identifying letter (A, B, C). In areas such as floor slabs and foundations, a sketch shall be prepared to identify pour locations. The following data shall be recorded to the cylinder mold at the time the cylinders are prepared and shall be included in the test report:
 - a. Test cylinder number and letter.
 - b. All foundations or structures covered by this test.
 - c. Proportions of concrete mix or mix identification.

- d. Maximum size coarse aggregate.
 - e. Specified compressive strength.
 - f. Slump, air content (where applicable) and fresh concrete temperature.
 - g. Date placed and time placed.
 - h. Ambient temperature at time of placement
 - i. Name of inspector making cylinders.
5. Test Cylinder Results: Specimens shall be tested in accordance with Standard Method of Test for Compressive Strength of Molded Concrete Cylinders (ASTM C 39).
- a. Cylinder A at seven (7) days. The result should be at least 60% of the specified 28 day compressive strength.
 - b. Cylinder B at 28 days.
 - c. Cylinder C shall not be tested but shall be kept in reserve for possible testing at a later date, not to exceed 60 days.
 - d. A report of test results shall be furnished directly to the Architect/Engineer.

END OF SECTION

DIVISION 4 MASONRY
SECTION 04 05 00 MORTAR AND GROUT FOR MASONRY

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM C 91 - Specification for Masonry Cement.
 - 2. ASTM C 94 - Specification for Ready-Mixed Concrete.
 - 3. ASTM C 109 - Test Method for Compressive Strength of Hydraulic Cement Mortars.
 - 4. ASTM C 143 - Test Method for Slump of Hydraulic Cement Concrete.
 - 5. ASTM C 144 - Specification for Aggregate for Masonry Mortar.
 - 6. ASTM C 150 - Specification for Portland Cement.
 - 7. ASTM C 207 - Specification for Hydrated Lime for Masonry Purposes.
 - 8. ASTM C 270 - Specification for Mortar for Unit Masonry.
 - 9. ASTM C 387 - Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - 10. ASTM C 404 - Specification for Aggregates for Masonry Grout.
 - 11. ASTM C 476 - Specification for Grout for Masonry.
 - 12. ASTM C 1019 - Method of Sampling and Testing Grout.
 - 13. ASTM C 1142 - Specification for Ready Mixed Mortar for Unit Masonry (Prohibited).
- C. IMIAC - International Masonry Industry All-Weather Council: Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

1.02 SUMMARY

- A. Section Includes: Mortar and grout for unit masonry.
- B. Related Sections:
 - 1. Section 04 73 00 Manufactured Stone Veneer

1.03 TESTING

- A. The Contractor shall employ the services of a qualified testing agency and laboratory to perform testing of mortar and grout.
- B. The Contractor shall give timely notice to the testing agency prior to the start of masonry work and during the progress of masonry work so that test specimens can be made and tested to adequately control the quality of the work.

1.04 QUALITY ASSURANCE

- A. Testing CMU Grout:
 - 1. Determine and certify that proportions of ingredients for mix design will provide the specified compressive strength for each type of grout.
 - 2. Test mix design prior to beginning construction of CMU walls. Test grout during construction of CMU walls 16 feet high, or higher, at the rate of one test for each 5000 square feet of wall. Test in accordance with ASTM C 1019.
- B. Mortar:
 - 1. Determine and certify that proportions of ingredients for mix design in accordance with ASTM C 270 will provide the specified strength.
 - 2. Test mortar during construction of CMU walls 16 feet high, or higher, at the rate of one test for each 5000 square feet of wall. Test mortar in accordance with ASTM C 109.

1.05 SUBMITTALS

- A. Submit mix proportions for grout and test data indicating mix meets the minimum strength required at 28 days.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store sand for mortar on plastic sheeting to prevent contamination by extraneous chemical in earth beneath.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Cold Weather Requirements: IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
 - 2. Specific Cold Weather Requirements: When the ambient air temperature is below 40 degrees F, heat mixing water to maintain mortar temperature between 40 degrees F and 120 degrees F until placed. When the ambient air temperature is below 32 degrees F, heat the sand and water to maintain this mortar temperature.
- B. For other measures and hot weather requirements refer to Section 04 21 00 and Section 04 22 00.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Portland Cement: ASTM C 150, normal-Type I or Type II; gray color. Fly ash, slag, and pozzolans not permitted as substitutes for Portland Cement.
- B. Mortar Aggregate: ASTM C 144, standard masonry type; clean, dry, protected against dampness, freezing, and foreign matter.
- C. Grout Aggregate: ASTM C 404; use of blast furnace slag is not permitted. Maximum coarse aggregate size, 3/8 inch.
- D. Calcium chloride is not permitted in mortar or grout. Admixtures or other chemicals containing Thyocyanates, Calcium Chloride or more than 0.1 percent chloride ions are not permitted.
- E. Hydrated Lime: ASTM C 207, Type S.
- F. Quicklime: ASTM C 5, pulverized to pass a #20 mesh sieve.
- G. Water: Potable.
- H. Admixtures: Not permitted unless approved by the Architect prior to construction.

2.02 MIXES - MORTAR

- A. Mortar: Type S for general use in accordance with the Proportion specification of ASTM C 270.
 - 1. Mortar Proportions:

Proportions by Volume			
Mortar Type	Portland Cement	Hydrated Lime or Lime Putty	Damp Loose Aggregate
S	1	1/2	2 1/4 to 3 times sum of volumes of cements and lime used

- 2. Mixing of components on-site is acceptable.
 - 3. Mixing on-site water and packaged dry blended mix for mortar (ASTM C 387) is acceptable.
 - 4. Use of ready mix mortar (ASTM C 1142) is prohibited.
- B. Pointing Mortar: Duplicate original mortar proportions. Add aluminum tristearate, calcium stearate, or ammonium stearate equal to 2% of Portland cement weight.
- C. Mortar Color: Control mortar mix to determine desired gray tone color. No additives.

2.03 MIXING - MORTAR

- A. Thoroughly mix mortar ingredients in accordance with ASTM C 270, in quantities needed for immediate use.
 - 1. Maintain sand uniformly damp immediately before the mixing process.
 - 2. Slake lime according to manufacturer's directions and allow to become cold before using.
 - 3. Provide uniformity of mix and coloration.
 - 4. Do not use anti-freeze compounds.
 - 5. If water is lost by evaporation, retemper only within 2 hours of mixing. Do not retemper mortar more than 2 hours after mixing.

2.04 MIXES - GROUT FILL

- A. Grout fill is for concrete masonry unit bond beams, lintels, and reinforced cells with reinforcing bars and embedded plates.
 - 1. Compressive Strength: 2500 psi minimum at 28 days, as determined in accordance with the provisions of ASTM C 1019.
 - 2. Slump: 8 inches, minimum; 10 inches, maximum, taken in accordance with ASTM C 143.
 - 3. Use coarse grout when grout space is equal to or greater than 4 inches in both directions.
 - 4. Use fine grout when grout space is smaller than 4 inches in either direction.
 - 5. Do not use air-entrainment admixtures.

2.05 MIXING - GROUT

- A. Grout: Batch and mix grout in accordance with ASTM C 94 or ASTM C 476 for site batched and mixed grout. Do not use anti-freeze compounds to lower the freezing point of grout.

PART 3 EXECUTION

3.01 INSTALLATION

- A. After reinforcing of masonry is securely tied in place, plug cleanout holes with masonry units. Brace against wet grout pressure.
- B. Install mortar and grout under provisions of Section 04 22 00.
- C. Provide control joints 20'-0" o.c. unless noted otherwise.

END OF SECTION

SECTION 04 22 00 CONCRETE MASONRY UNITS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Provide concrete masonry units (CMU), in place, with reinforcing, flashing, control joints, and other accessories for structurally sound walls and partitions.
- B. Provide split-face concrete masonry veneer units as indicated on the Drawings.
- C. Provide decorative cast stone panels, solids, and special shapes required by Drawings for corners, cantilevers, and other unique conditions.

1.03 TESTING

- A. The Contractor shall employ the services of a qualified testing agency and laboratory to perform testing of masonry as required in these Specifications.
- B. The Contractor shall give timely notice to the testing agency prior to the start of masonry work and during the progress of masonry work so that prisms can be made and tested to adequately control the quality of the work.

1.04 SAMPLE WALL

- A. At starting of masonry work, build a sample section of CMU wall, including brick veneer where applicable, approximately 4 x 8 feet, representative of the proposed method of laying and workmanship and secure Architect's approval before proceeding with the remaining work. Sample wall section may become part of finished walls, if approved. Build additional samples if required.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store on the site, CMU, sufficient in quantity for the entire job, and secure approval by Architect before placing any of same in the work.
- B. Store CMU on pallets above grade.
- C. Handle and transport CMU using methods that will protect them from damage. Replace any damaged units at no cost to the Owner.

PART 2 PRODUCTS

2.01 LIGHTWEIGHT CONCRETE MASONRY UNITS

- A. Units shall be made with Haydite aggregate and conform to the following:
 - 1. ASTM C 90 Hollow Load-Bearing Concrete Masonry Units, Type 1, Grade N-1.
 - 2. Maximum linear shrinkage 0.025% as measured by ASTM C 426.
 - 3. Maximum moisture content at delivery reduced to 30% of total absorption as measured by ASTM C 140. Plant-cure units a minimum of 28 days before delivery.
 - 4. Sizes: Nominal 8" x 16" face, two-cell units of 4", 6", 8" or 12" thickness as indicated, with half units, square-end corner units, solid units, jamb units, brick units, header units, bond beam lintel units, bullnose units, pilaster units, and other units necessary to maintain the bond and as otherwise indicated.
- B. Lightweight concrete masonry units shall be as manufactured by Joplin Building Materials, Neosho Concrete, or approved equal, approved seven (7) days before bidding.
- C. Concrete masonry units, required to be in fire rated walls, as indicated on the Drawings, shall be certified by a recognized testing agency to have the required time-design fire resistance rating.

- D. Perform prism testing in accordance with Article 3.05. Average compressive strength of 3 prisms shall not be less than 2000 psi.

2.02 DECORATIVE CAST STONE

- A. Cast stone shall be Accent Cast Stone as manufactured by Joplin Building Materials, or approved equal.
- B. Units shall be of the dimensions and design indicated on the Drawings. Color shall be selected by Architect.

2.03 REINFORCEMENT (BLOCK MESH)

- A. Single Wythe Exterior Walls: Dur-O-Wal extra heavy truss design, 3/16" side rods and No. 9 cross rods, wall reinforcing, of proper size and shape as required for wall thickness as shown on the Drawings. All walls shall have reinforcing at 16" o.c. vertically. Stacked bond load bearing walls shall have in addition, reinforcing at 8" o.c. in the top three courses.
- B. Single Wythe Interior Walls: Dur-O-Wal Standard truss design, or approved equal, No. 9 side and cross rods, masonry wall reinforcing, of proper size and shape as required for wall thickness as shown on the Drawings. All walls shall have reinforcing 16" o.c. vertically. Stacked bond load bearing walls shall have in addition, reinforcing at 8" o.c. in the top three courses.
- C. Double Wythe Walls: Dur-O-Wal extra heavy truss design, 3/16" side rods and No. 9 cross rods, of sufficient width for both wythes plus cavity between wythes. Cross rods shall have a vee-drip located in the cavity. For exterior double wythe walls, reinforcement shall be hot-dipped galvanized in accordance with ASTM A 153, Class B-2.
- D. Provide corresponding prefabricated corner and tee reinforcement at all corners and intersections.

2.04 REINFORCEMENT (BARS)

- A. ASTM A 615, Grade 60.

2.05 CONCEALED FLASHING

- A. Concealed flashing, where indicated on Drawings, shall be TAMKO TW THRU WALL flashing, 40 mil (0.040") self adhering sheet membrane rubberized asphalt as manufactured by TAMKO Building Products, or approved equal.

2.06 CAVITY WALL INSULATION

- A. Insulation boards shall be extruded polystyrene board, 2 inch thickness, 16 inches wide.
 - 1. Aged R-value: 5.0 per inch in accordance with ASTM C 518.
 - 2. Water Vapor Permeance: 0.4 - 1.1 perms in accordance with ASTM E 96.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, preparatory work, and conditions under which work of this Section will be performed. Correct any unsatisfactory conditions. Do not proceed with masonry work until unsatisfactory conditions have been corrected.
- B. Beginning masonry work indicates acceptance of existing conditions.

3.02 INSTALLATION

- A. Lay no units having a film of water or frost on their surfaces.
- B. Lay no masonry when temperature is below 45 degrees F, unless it is rising, and at no time when below 40 degrees F, without Architect's permission. Such permission shall not relieve the Contractor from responsibility for the work, however. If permitted to work below 40 degrees F, make provisions to heat and dry materials and protect work from freezing.
- C. Build in bolts, ties, other metal anchors, sleeves, miscellaneous metals, and wood nailing strips as necessary to secure masonry together or to other materials. Use no continuous wood nailing strips.
- D. Build in steel lintels, bearing plates and flashings in contact with masonry. Bed flashings in mortar.

- E. Close up any recesses after pipes, ducts, conduits and other items are in and have been inspected by Architect and/or other proper authorities and do all patching after other trades have completed their work. Special attention shall be taken in closing all voids at cuts for outlet boxes, plumbing rough-ins, cleanouts, or other temporary openings.
- F. Cut exposed masonry with masonry saw to produce clean-cut edges. Other than water used in cutting operations, allow no wetting of blocks prior to laying.
- G. Provide insulation boards between concrete block wall and brick at exterior wall as indicated on the Drawings. Install insulation in as great a length as possible, minimizing end joints. Fill all joints tight and tape covered. Tape as recommended by the manufacturer.
- H. At end of each work day or shut down period, cover walls with strong waterproof membrane overlapping walls 12 inches minimum on each side and securely anchor in place.
- I. Use a full height story pole at all corners. Level first and frequent courses with instrument.
- J. Build in door and window frames and their anchors. Slush steel door frame jambs and heads full of grout. Slush cells full of mortar where excessive cutting for conduit or other devices has weakened masonry.
- K. Where fresh masonry adjoins previously set masonry, clean, roughen and lightly wet the set masonry before joining with new. Where stop-offs are necessary in horizontal runs, rake back the masonry; toothing not permitted unless approved by Architect.
- L. Build walls and partitions to dimensions indicated, in courses 8" high in stacked bond with units stacked one over the other with vertical and horizontal joints aligned, at the locations indicated on the Drawings.
- M. Reinforce walls and partitions with block mesh using appropriate types indicated above and in nominal width of wall or partition. Unless indicated otherwise, place a layer immediately above and below openings and elsewhere in every second course, with ends lapped 6" and alternately staggered. Bond corners and intersections with prefabricated corner and partition units.
- N. Set reinforcing bars in bond beam lintel units and shear walls. Position bars as indicated, fill cavity with grout and puddle to effect good contact with steel and block. Finished lintel must bear 8" minimum at each jamb.
- O. Install all special shapes as indicated on Drawings or as required.
- P. Where partitions abut exterior walls, rake out continuous vertical joint 3/8" x 1" to receive caulking by other trades, as specified in Section 07 92 00.
- Q. Provide control joints 40'-0" o.c. unless noted otherwise.

3.03 JOINTS

- A. Set in mortar joints 3/8" thick with full coverage on vertical and horizontal face shells.
- B. Except as noted, after mortar has begun to set, compact with tool to form concave joints where such joints will be exposed. Where concealed behind gypsum board or other finishes, compact joints smooth and flush. Brush excessive mortar from edges. After mortar has set, buff any remaining protruding mortar from joints.

3.04 POINTING AND CLEANING

- A. At building completion, when roofing work and heating system is operational or at such other time as Architect may direct, point up all exposed masonry, fill all holes and joints; remove loose mortar, cut out defective joints, repair cracks and defects, and repoint where necessary. Thoroughly clean masonry surfaces to be exposed, painted or unpainted.
- B. After walls have been "topped-out" and allowed to dry a minimum of seven (7) days, clean split-face veneer units along with face brick surfaces with cleaner; the specific formulation of cleaning agent to be determined by consultation between cleaner manufacturer and masonry manufacturer, based on the final masonry selection and the installation conditions. Apply cleaning agent and rinse per manufacturer's directions and as hereinafter specified. If required by manufacturers, mask each type of masonry veneer when cleaning other types.
- C. Carefully clean masonry, removing large particles of mortar with a putty knife or chisel. Before the cleaning agent solution is applied, thoroughly soak surface with clean water. Apply solution with long-handled, stiff

fiber brush, taking precaution to cover clothing, hands, and arms to prevent burns. Place over area no greater than 15 to 20 sq. ft. before the wall is again hosed down with clear water immediately after cleaning. Remove all trace of cleaner before it attacks the mortar joints.

- D. At least two weeks prior to time cleaning is to be done, clean a 20 sq. ft. sample area of wall, designated by Architect. After two week interval, Architect will inspect and if he finds no adverse affects, Contractor shall clean remaining wall. Should adverse affects be discovered, Architect will direct revised cleaning measures.

3.05 TESTING

- A. Prior to start of any concrete masonry construction perform prism tests in accordance with ASTM E 447, Method A, and ACI 530.
- B. During concrete masonry construction of walls 16 feet high, or higher, perform prism tests for each 5000 square feet of wall area, in accordance with ASTM E 447, Method B, and ACI 530.
- C. Walls or portions of a wall for which the prism test results do not meet the required average compressive strength shall be removed, replaced, and new prism tests performed for the replacement.

END OF SECTION

DIVISION 5 METALS

SECTION 05 12 00 STRUCTURAL STEEL

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. American Institute of Steel Construction (AISC): Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 36 - Specification for Structural Steel.
 - 2. ASTM A 53 - Specification for Pipe, Steel, Black and Galvanized, Seamless and Welded.
 - 3. ASTM A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 5. ASTM A 325 - Specification for Structural Bolts, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 6. ASTM A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 7. ASTM A 501 - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 - 8. ASTM A 992 - Specification for Steel for Structural Steel Shapes.
- D. American Welding Society (AWS): ASW D1.1 - Structural Welding Code.
- E. Steel Structures Painting Council (SSPC):
 - 1. SSPC-Paint 20 Type II - Zinc Rich Primers - Organic.
 - 2. SSPC-Paint 25 - Red Iron Oxide, Zinc Oxide, Raw Linseed Oil, and Alkyd Primer.
 - 3. SSPC-SP 2 - Hand Tool Cleaning.

1.02 SUMMARY

- A. Section Includes:
 - 1. Structural steel framing members, structural steel support members, with required welds, and fasteners.
 - 2. Base plates.
 - 3. Loose lintels to be installed with masonry.
 - 4. Anchor rods required for items included in this Section.
 - 5. Support plates and angles with anchor studs, sleeve anchors, expansion bolts, or adhesive anchors, which are embedded in or cast into concrete or masonry.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast In Place Concrete: Anchorages cast in concrete.
 - 2. Section 04 22 00 - Concrete Masonry Units.

1.03 SUBMITTALS

- A. Submit shop drawings for fabrication and erection of structural steel. Show anchorage and accessory items. Indicate erection sequence.
- B. Provide templates for anchor and bolt installation by other trades.

1.04 QUALITY ASSURANCE

- A. Qualifications for Welding Work: Qualify welding operators in accordance with AWS Standard Qualification Procedures. Provide certification that welders employed in work have satisfactorily passed AWS qualification tests within previous 12 months. If recertification of welders is required, provide without additional cost to Owner.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Transport, handle, store and protect products in a manner that prevents damage.
- B. Product Packaging and Marking: Steel shall come with identification markings on each component or package. Identification markings shall coordinate with identification markings for components indicated on setting drawings.
- C. Defects: Report suspected product manufacturing or fabrication defects to Owner's Representative. Arrange for repair or replacement of defective items.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Structural Steel Shapes, Plates and Bars: ASTM A 36, or ASTM A 992.
- B. Structural Tubing: ASTM A 500, Grade B.
- C. Structural Steel Pipe: ASTM A 53, Grade B; ASTM A 500, Grade B; ASTM A 501.
- D. Bolts, Nuts, and Washers: ASTM A 325 or A 307 as indicated on Drawings.
- E. Welding Materials: ASW D1.1; type required for materials being welded or as indicated on Drawings.
- F. Alkyd Primer: SSPC-Paint 25.
- G. Zinc Rich Primer: SSPC-Paint 20 Type II.
 - 1. Carboline 858, by Carboline.
 - 2. 90-97 Tneme-Zinc, by Tnemec.

2.02 FABRICATION

- A. Fabricate structural steel members in accordance with AISC Specifications.
- B. Connections not detailed on Drawings: Engineer by fabricator, which is subject to review.
- C. Make provision for connections of other work, including necessary cutting, drilling, punching and tapping, where indicated by Drawings or where information is furnished prior to or at time of approval of shop drawings.
- D. Fabricator's Responsibility:
 - 1. Errors of detailing, fabrications, and for correct fitting of structural steel members.
 - 2. Do not splice structural steel members. Members having splice not indicated on Drawings will be rejected.

2.03 PAINTING

- A. Paint interior steel one shop coat of gray primer conforming to SSPC-Paint 25. Leave unpainted, steel to be encased in concrete and those surfaces within 4" of a field weld joint.
- B. Paint lintels and other steel exposed to the weather with a zinc-rich primer conforming to SSPC-Paint 20, Type II.
- C. Prepare structural steel items scheduled to receive primer by SSPC-SP 2 (Hand Tool Cleaning) method.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions under which structural steel work is to be installed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Supply items required to be cast into concrete or embedded in masonry with setting diagrams to appropriate trades.

3.03 CONTROL

- A. Establish permanent bench marks as necessary for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds. Do not proceed with erection until corrections of discrepancies have been made, or until compensating adjustments to structural steel work have been agreed upon.

3.04 ERECTION

- A. Erect structural steel in accordance with AISC Specification.
- B. Make provision for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Do not field cut or alter structural members.
- D. After erection, paint surfaces not shop painted that are to receive finish painting, except surfaces to be in contact with concrete. Use a primer consistent with shop coat.
- E. Anchor Rods: Install anchor rods and other connectors required for securing structural steel to foundations and other in-place work. Furnish templates and other devices as necessary for presetting rods and other anchors to accurate locations.
- F. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surfaces of base and bearing plates.
 - 1. Set loose and attached base plates and bearing plates for structural members on adjusting nuts.
 - 2. Tighten anchor rod nuts after the supported members have been positioned and plumbed.
 - 3. Grout (non-shrink and non-metallic) solidly between bearing surfaces and bases of plates immediately after erecting member and before additional load is placed on member. Finish exposed surfaces, protect

installed materials, and allow to cure. For proprietary grout materials, comply with manufacturer's installation instructions.

G. Touch-up Painting:

1. Immediately after erection, clean exposed field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION

DIVISION 6 WOOD AND PLASTICS
SECTION 06 10 00 ROUGH CARPENTRY

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Rough carpentry includes blocking, nailers, framing, furring, and other wood items required for support and attachment of other construction materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Framing lumber:

<u>Use</u>	<u>Grade</u>	<u>Species</u>
Studs, Joist & Plates	No. 2	Southern Pine
Other Blocking, Nailers, Furring	Utility	Any Species
- B. Blocking and nailers in contact with block, concrete, roof deck, or roof membrane shall be treated to prevent decay and meet AWP A Standard C2 and ASTM E 84. Lumber shall be grade stamped and bear AWP A mark.
- C. Lumber and Boards: Sound, kiln-dried to 19% moisture content, maximum, well manufactured and free from warp that cannot be corrected by bridging or nailing. Unless otherwise indicated, furnish dressed wood for exposed-to-view work and S4S for concealed work.
- D. Grade and trade mark each piece of lumber (or each bundle). (Not required if each shipment is accompanied by certificate of inspection issued by grading association.)
- E. Plywood: U.S. Product Standard PS 1; size and grade as indicated or as appropriate for the use.
- F. Nails, spikes, bolts, washers, nuts, screws, gun-driven pins, and other anchors and accessories indicated or required to secure all items. Fasteners for use with preservative treated wood shall have coatings or be of a corrosion resistant material that will provide long-term protection from the corrosive effect of the preservative.

PART 3 EXECUTION

3.01 FRAMING

- A. Frame openings required by other trades.
- B. Add nailers, blocking, and furring as necessary to secure finish materials and fixtures.
- C. Unless indicated, cut all members square and erect in full bearing; nail, screw or otherwise rigidly secure.

END OF SECTION

SECTION 06 40 00 ARCHITECTURAL WOODWORK

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. This Section includes furnishing and installing:
 - 1. Standing and running trim.
 - 2. Cabinets and shelving.
 - 3. Countertops.

1.03 SUBMITTALS

- A. Shop Drawings: Submit shop drawings indicating dimensions, materials, fastenings, joinery, and interface with other materials.
 - 1. Cabinet shop drawings shall include plans, elevations, sections, trim details, and hardware.
- B. Samples: Submit samples of plastic laminate and grommets for color selection.
- C. Warranty: At the completion of the cabinetry and casework, submit manufacturer's written warranty covering installation, material, and workmanship for not less than one (1) year from time of completion of the work.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. All wood kiln-dried to 6% to 11% moisture content for interior; 9% to 12% for exterior.
- B. All oak suitable for transparent finish.

2.02 INTERIOR TRIM MATERIALS

- A. Solid lumber for interior finish trim unless specified otherwise on Drawings, shall be select oak.

2.03 CABINETS AND CASEWORK

- A. Cabinets and casework, unless noted otherwise, shall be as follows:
 - 1. Exposed face of cabinets shall be high pressure laminate of flush overlay construction.
 - 2. Furnish all anchors required for attachment of all units to walls and unit to unit.
 - 3. All cabinets shall conform to custom grade as defined in AWI Quality Standards, Sixth Edition, Version 1.1, Section 400B.
 - 4. Colors shall be as selected by Architect for all laminate interiors, exteriors and trim.
- B. Construction:
 - 1. Joinery: Cabinet corner joints incorporating dowel pin construction must be glued and clamped under pressure to assure rigid load-bearing corner joints.
 - 2. End Panels: All cabinet ends shall be ¾" thick panels of balanced construction, precision bored for dowel pins installed in horizontal cabinet members. All units shall have continuous one piece end panels for added load capabilities.
 - 3. Bottoms and Tops: All cabinet bottoms and tops shall be ¾" thick panels of balanced construction. Panels shall be precision bored to receive fluted dowel pins, inserted with glue. Dowel pins shall extend from the panel ends into mating hole patterns in the cabinet's side panels.
 - 4. Doors: Solid hinged doors shall be ¾" thick material of balanced construction. Doors 36" and less in height shall have two (2) hinges per door. Door over 36" must have three (3) hinges per door. All edges must be finished with set-in PVC edging of a minimum 3 mm thickness.
 - 5. Cabinet Backs: All unit backs shall be ¼" thick panels with laminate interior surface.

6. Drawers: Fronts shall be $\frac{3}{4}$ " thick material of balanced construction. Sides and ends shall be medium density particle board. Bottoms shall be $\frac{1}{4}$ " medium density particle board. Fronts shall be finished with set-in PVC edging of a minimum 3 mm thickness.
7. Adjustable Shelves: All adjustable shelves in cabinets shall be $\frac{3}{4}$ " thick when under 36" long and 1" thick when 36" long and over. Front edges shall have a set-in PVC edging of a minimum 3 mm thickness.

C. Plastic Laminate Countertops:

1. High pressure decorative plastic laminate shall be bonded to top, edges, and backsplash of industrial grade medium density particle board. Make straight runs in one piece whenever possible.
2. Countertops shall conform to custom grade as defined in AWI Quality Standards, Sixth Edition, Version 1.1, Section 400C.
3. Provide a post-formed high pressure decorative laminate edge at countertop edges not having a backsplash.
4. General Contractor shall cut holes in countertops for sinks, lavatories, grommets, and other inserts as required by various trades.

D. Material:

1. Cores: Cores shall be medium density particle board.
2. Interior Surfaces: All interior surfaces shall be laminated. Surfacing shall perform as tested under standards of NEMA tests LQ1-3.01 through LQ1-3.10.
3. Exterior Surfaces: Plastic laminate for exterior surfaces (doors, drawers, cabinets, countertops and splashes) shall be bonded to base materials as specified. Plastic laminate shall be 0.050 inch nominal thickness as manufactured by Formica, Wilson Art, or Textolite.
4. Edges: Shelves and cabinet members shall be edged with plastic laminate. Doors and drawers shall be edged with set-in PVC edging of a minimum 3 mm thickness.

E. Hardware:

1. Pulls: Stanley #4484.
2. Hinges: Blum 77M5580 Self Closing Hinge with 175L6600.22 Mounting Plates for Face Frame.
3. Shelf Supports: Dual pin, snap in place units for 32MM drilled holes.
4. Drawer Guides: K & V #1300.
5. Grommets: Doug Mockett #BG - color to match laminate.
6. All hardware shall have satin chromium finish unless otherwise noted.
7. Support Brackets for Counters: Standard mount bracket of 11 gauge steel, in sizes as indicated on the Drawings. Finish shall be powder coat in color selected by Architect.
 - a. Manufacturer: Gambas or A&M Hardware, Inc.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all miscellaneous finish carpentry items indicated, in straight, true alignment with tight hairline joints between items.
 1. Apply finish in longest practical lengths; miter external corners; cope re-entrant corners; scarf splices, make all joints tight. Leave work in prime condition for finishes by other trades.
 2. In general, radius edges slightly, but where details indicate square edges, furnish as such and touch-sand exposed edges after installation.
- B. Install hardware, metal, and other specialty items as indicated, where not installed by other trades.
- C. Anchor all casework in place with concealed fastening systems and scribe to adjoining surfaces as required and as indicated in shop drawings.
- D. Field Jointing Tops:
 1. Where practicable, make in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer.
 2. Locate field joints as shown on accepted shop drawings, factory prepared so that there is no job site processing to top and edge surfaces.

3. Abut top and edge surfaces in one true plane, with internal supports placed to prevent any deflection.
4. Provide flush hairline joints in top units.
5. Scribe and cut for accurate fit.

END OF SECTION

SECTION 07 21 00 THERMAL INSULATION

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Provide, install and complete all building insulation shown on the Drawings or specified herein, or both, including:
 - 1. Perimeter insulation under floor slab.
 - 2. Batt insulation (ceilings, walls & misc. closures).
 - 3. Firesafing (mineral wool batting).

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original packaging with labels indicating the manufacturer, type of material, thickness, and R value.
- B. Handle and store products in a manner to prevent damage and moisture absorption.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Board Insulation at Perimeter: Insulation boards shall be 2 inches thick extruded polystyrene board of the dimensions indicated on the Drawings.
 - 1. Aged R-value: 5.0 per inch in accordance with ASTM C 518.
 - 2. Water Vapor Permeance: 0.4 - 1.1 perms in accordance with ASTM E 96.
- B. 4", 6", 9", or 12" kraft faced fiberglass insulation (rolls or batts) as required for use in ceilings, walls & miscellaneous areas as shown on the Drawings.
- C. Mineral wool batting for firesafing shall be a non-asbestos compound as manufactured by U.S. Gypsum Corporation with a trade name of "Thermafiber Safing"; 4 lbs. per cubic foot. The batting shall be unfaced and in thickness as required for the specific application.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install insulation in as great a length as possible, minimizing end joints. For faced insulation, tape end joints.
- B. Provide adequate coverage so that insulation R value is provided for a complete wall or ceiling area.
- C. Fit insulation into constricted areas to achieve complete coverage.
- D. Fit mineral wool batting into gaps requiring a fire barrier as indicated on the Drawings.

END OF SECTION

SECTION 07 24 00 EXTERIOR/INTERIOR INSULATION AND FINISH SYSTEM

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. ASTM B 117 (Federal Test Standard 141A Method 6061) Test Method of Salt Spray (Fog) Testing.
- C. ASTM C 150 Specification for Portland Cement.
- D. ASTM C 297 Test Method for Tensile Strength of Flat Sandwich Constructions in Flatwise Plane.
- E. ASTM D 968 (Federal Test Standard 141A Method 6191) Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive.
- F. ASTM D 2247 (Federal Test Standard 141A Method 6201) Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
- G. ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM E 96 Test Methods for Water Vapor Transmission of Materials.
- I. ASTM E 330 Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- J. ASTM E 331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- K. ASTM G 23 (Federal Test Standard 141A Method 6151) Recommended Practice for Operating-Exposure Apparatus (Carbon-Arc Type) With and Without Water, for Exposure of Nonmetallic Materials.
- L. EIMA Std 101.86 Standard Test Method for Resistance of Exterior Insulation Finish Systems (EIFS), Class PB to the Effects of Rapid Deformation (Impact).

1.02 SYSTEM DESCRIPTION

- A. General: The Dryvit Outsulation System shall be an Exterior and Interior Insulation and Finish System (EIFS), Class PB, consisting of an adhesive, insulation board, base coat with reinforcing fabric and finish.
- B. Method of Installation: The Exterior and Interior Insulation and Finish System shall be field applied to the substrate system in place.
- C. Performance Requirements:
 - 1. The System shall have been tested for durability as follows:
 - a. Abrasion Resistance: ASTM C 968 (Federal Test Standard 141A Method 6191); no deleterious effects after 500 liters (132 gal).
 - b. Absorption-Freeze-Thaw: 60 cycles, soak at 20°C (68°F) for four days, then -10°C (14°F) for two hours, then 20°C (68°F) for two hours; no checking, cracking, or splitting.
 - c. Accelerated Weathering: ASTM G 23 (Federal Test Standard 141A Method 6151); 2,000 hours. No deterioration.
 - d. Mildew Resistance: MIL Std 810B; passes.
 - e. Moisture Resistance: ASTM D 2247 (Federal Test Standard 141A Method 6201); no deleterious effects after 14 days.
 - f. Salt Spray Resistance: ASTM B 117 (Federal Test Standard 141A Method 6061); 5% concentration for 300 hours. No deleterious effects.
 - g. Water Penetration: ASTM E 331; no water penetration to the innermost surface of the test specimen.
 - h. Water Vapor Transmission: ASTM E 96 Water Method, Procedure B; Standard lamina: 10 g/hr•m² (14 gr/hr•ft²).
 - 2. The System shall have been tested for structural performance as follows:
 - a. Bond Strength: ASTM C 297; minimum 132 kPa (19.1 psi); failure in the substrate or insulation board.

- b. Full Scale Structural Tests: ASTM E 330; minimum failure load under positive or suction force of 4.3 kPa (90 psf) unless otherwise specified; substrate failure.
 - c. Impact Resistance: In accordance with EIMA Standard 101.86: "Standard".
- 3. The System shall have been tested for fire performance as follows:
 - a. Flame Spread - ASTM E 84. When tested individually;
 - 1) The EPS insulation board shall have a Flame Spread index not exceeding 25 and a Smoke Developed index not exceeding 450.
 - 2) The adhesives and coatings shall have a Flame Spread index not exceeding 20 and a Smoke Developed index not exceeding 10.

1.03 SUBMITTALS

- A. Product Data: Submit Manufacturer's product data sheets describing products which will be used on this project.
- B. Samples: Submit two samples of the system for each finish, texture, and color to be used on the project. The same tools and techniques proposed for the actual installation shall be used. Samples shall be of sufficient size to accurately represent each color and texture to be utilized on the project.
- C. Test Reports: When requested, submit to the Architect copies of selected test reports verifying the performance of the Exterior Insulation and Finish System.

1.04 QUALITY ASSURANCE

- A. The installer shall have a demonstrable record of not less than 5 years experience in the installation of Exterior Insulation and Finish Systems. Additionally the installer shall possess a current trained contractor certificate from the EIFS manufacturer.
- B. Insulation Board Manufacturer shall be listed by Dryvit Systems, Inc., shall be capable of producing the expanded polystyrene (EPS) in accordance with current Dryvit Specification for Insulation Board, and shall subscribe to the Dryvit Third Party Certification and Quality Assurance Program.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered to the job site in the original, unopened packages with labels intact.
- B. Upon arrival, materials shall be inspected for physical damage, freezing, or overheating. Questionable materials shall not be used.
- C. Materials shall be stored at the jobsite in a cool, dry location, out of direct sunlight, protected from weather and other damage. Minimum storage temperature shall be 45°F.

1.06 SEQUENCING AND SCHEDULING

- A. Installation of the EIFS system shall be coordinated with other construction trades.
- B. Sufficient manpower and equipment shall be employed to ensure a continuous operation, free of cold joints and texture variations.

1.07 WARRANTY

- A. Provide manufacturer's standard five (5) year limited warranty against defective materials.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Exterior Insulation and Finish System shall be Class PB as manufactured by Dryvit Systems, Inc., or equivalent as approved by the Architect.

2.02 MATERIALS

- A. Portland Cement shall be Type I, I-II, or II meeting ASTM C 150, white or gray in color, fresh and free of lumps.

- B. Water shall be clean and free of foreign matter.
- C. Adhesives used to adhere the EPS to the substrate, shall be compatible with the substrate and the EPS.
 - 1. Cementitious: A liquid polymer based material, which is field mixed with Portland cement for use over non wood-based substrates - Dryvit Primus as manufactured by Dryvit Systems, Inc.
- D. Insulation Board:
 - 1. 2" expanded polystyrene.
 - 2. The surface burning characteristics of the EPS shall be classified by Underwriters Laboratories and be listed in the U. L. Building Materials Directory as having a Flame Spread and Smoke Development rating of not greater than 25 and 450 respectively in accordance with ASTM E 84.
 - 3. 1.0 lbs./cu. ft. average density.
 - 4. K=0.23 per inch.
 - 5. Federal Specification HH-1-524B, Type I, Class A.
 - 6. Aged (air dried) for six weeks before use.
 - 7. The following dimensional tolerance shall apply for insulation board in lieu of Federal Specification HH-1-524B:
 - a. Edges shall be square within 1/32" per foot.
 - b. Thickness shall be within a tolerance of $\pm 1/16$ ".
 - 8. Manufactured by Dryvit Systems, Inc. approved and licensed manufacturer.
- E. Base coat shall be compatible with the EPS insulation board and reinforcing fabric.
 - 1. Cementitious: A liquid polymer based material, which is field mixed with Portland cement - Dryvit Primus as manufactured by Dryvit Systems, Inc.
- F. Reinforcing Fabric: balanced open weave glass fiber fabric made from twisted multi-end strands, specifically treated for compatibility with Dryvit materials.
- G. Finishes shall be the type, color, and texture as selected by the Architect.
 - 1. Standard DPR (Dirt Pickup Resistance): Water based, acrylic coatings with integral color and texture, and formulated with DPR chemistry - Quarzputz®, Coarse texture as manufactured by Dryvit Systems, Inc.
- H. Accessories:
 - 1. Corner beads: Wire type at external corners.
 - 2. Casing beads: At locations where EIFS abuts dissimilar material.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Prior to installing the EIFS examine the substrate to determine if substrate is:
 - 1. Flat within ¼ inch in a 4 foot radius.
 - 2. Sound, dry, with no surface voids or projections or other conditions that may interfere with the EIFS installation.
- B. Ascertain that all required flashing and other waterproofing details have been completed.
- C. Ascertain that substrate is free of oil, dirt, dust, frost, or other material that could inhibit adhesion.
- D. Beginning installation indicates approval of existing conditions.

3.02 INSTALLATION

- A. Install the system in accordance with the current application instruction of the manufacturer.
- B. Use the notched trowel method of adhesive application over gypsum sheathing substrate.
- C. No additives such as rapid binders, anti-freeze, or accelerators shall be added to any Dryvit material under any circumstances.
- D. For installation in ambient temperatures less than 40°F., supplementary heat shall be provided. A minimum ambient temperature of 40°F. shall be maintained for at least 24 hours after installation.
- E. Subsequent to installation, the wall shall remain free of residual moisture.

- F. Mixing Dryvit Primus/Adhesive: Use clean container, free of all foreign substance, for mixing and preparing material. Mix Type I Portland Cement with Primus/Adhesive in a ratio, by volume, as recommended by Dryvit Systems, Inc. This mixed Primus/Adhesive shall be used for insulation board adhesive and Primus coating.
- G. Applying Insulation Board: The application of insulation board to vertical surfaces shall begin at the base from firm, permanent or temporary support. Adhesion shall be made to a clean, hard surface. Precut insulation board as required to fit openings, projects, and rustications. Stagger vertical joints. By trowel or extrusion, apply a ribbon of mixed Primus/Adhesive approximately 2" wide by 1/4" to 3/8" thick to the entire perimeter of each board. Apply dabs or ribbons of the same thickness to the interior area approximately 8" on center. Apply pressure over entire surface of board to insure uniform contact and high initial grab. Abut all joints tightly and insure an overall flush plane surface. All areas where the EIFS joins other materials or terminates at roof lines, must be protected in order that no water can penetrate behind the insulation board.
- H. Install corner beads and casing beads as required. Space control joints to provide panels no more than 20 feet long.
- I. Dryvit Primus Coating and Reinforcing Fabric: Using a stainless steel trowel, apply mixed Dryvit Primus/Adhesive to the entire surface of the insulation board to a uniform thickness of approximately 1/16". For this use, water may be mixed with the mixed Primus/Adhesive to enhance workability. Immediately place the reinforcing fabric against the wet Primus coating, and by troweling from the center to the edges, embed the fabric into the coating. Reinforcing fabric shall be continuous at corners and lapped not less than 2 1/2" at fabric edges. Avoid wrinkles in embedding the reinforcing fabric. The finished thickness of the Primus Coating shall be such that the reinforcing fabric is fully embedded.
- J. Dryvit Quarzputz Finish: Thoroughly mix the factory prepared sandblast Finish material with a high speed mixer until a uniform workable consistency is attained. Clean water may be added to adjust workability to suit. Using a clean stainless steel trowel, apply a tight coat of the sandblast Finish directly to the reinforced Primus Coating.

3.03 PROTECTION

- A. The EIFS shall be protected from weather and other damage until permanent protection in the form of flashings and sealants are installed.

END OF SECTION

SECTION 07 60 00 FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA) - Architectural Sheet Metal Manual, Latest Edition.

1.02 SUMMARY

- A. Work of this Section includes sheet metal flashing required at roof penetrations, where roofs abut vertical surfaces, gutters, downspouts, and other sheet metal required to provide a weather tight enclosure.
 - 1. Field formed and fabricated items.
- B. Related Work Specified Elsewhere:
 - 1. Section 07 50 00 Membrane Roofing
 - 2. Section 07 54 00 Thermoplastic Membrane Roofing
 - 3. Section 07 71 00 Roof Specialties

1.03 SCHEDULE

- A. Coordinate the work of this Section with the installation of the membrane roofing to provide a complete system that qualifies for the membrane roofing warranty.

PART 2 PRODUCTS

2.01 MATERIAL FOR FIELD FABRICATION

- A. Sheet Metal: ASTM A 39.
- B. Galvanized Steel Flashings:
 - 1. Counterflashing: 24 gauge
 - 2. Pitch Pans and Umbrella Flashing: 24 gauge with all joints of pans seamed and soldered.
- C. Lead Flashings: 4 lb. sheet lead (2 ½ lb. at roof drains).

2.02 PREFINISHED SHEETMETAL

- A. Pre-painted architectural sheet metal shall be AlumaKlad as manufactured by Vincent Metal Goods, Building Products Group, or approved equal. Base metal shall be 0.050 aluminum, primed and finished one side with Kynar 500 based fluoropolymer coating 1.0 ± 0.1 mil total dry film thickness.
- B. A wash coat of 0.3 – 0.4 mil dry film thickness shall be applied to the reverse side.
- C. The pre-painted finished side shall be coated with a liquid applied factory installed strippable film for protection of the finished surface during shipping, fabrication, and installation.
- D. The material shall be protected from heat and direct sunlight to prevent deterioration of the strippable film and possible damage to finished coating.
- E. Color shall be selected by the Architect from AlumaKlad standard colors.

2.04 PRE-FINISHED SOFFIT PANEL

- A. Manufacturer: MBCI, Aepspan or approved equal.
- B. System: Artisan Series 26 ga. Steel LI2 profile concealed fastening.
- C. Finish: Galvalume panel w/ "Signature" 200 silicone polyester coating. Color to be selected by Architect.
- D. Accessories: Closure trim, finish to match panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that the installation of flashing and sheet metal will not disrupt the work of other trades.

- B. Verify that the substrate is dry, clean, and free of foreign matter. Correct defects before beginning installation.

3.02 INSTALLATION

- A. All fabrication and installation shall be performed by skilled, competent workmen. The workmanship of all sheet metal work, method of forming joints, provision for expansion, and attachment shall conform to the SMACNA Architectural Sheet Metal Manual.
- B. Prefinished Sheet Metal:
 - 1. Installation shall be accomplished with strippable film in place.
 - 2. Cut, form, and install sheetmetal conforming to the recommendations of the Sheet Metal and Air Conditioning Contractors National Association.
 - 3. Maintain sharp, clean, properly dressed, and closely aligned cut edges.
 - 4. Install sheet metal flashing in a straight, plumb, and secure manner.
- C. Gutters and downspouts:
 - 1. Install gutters and downspouts in a secure manner, making sure that adequate drainage is provided.
 - 2. Seal joints and connections against leakage.
 - 3. Transition downspouts to underground rainwater collection system.

END OF SECTION

SECTION 07 84 00 FIRESTOPPING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. Test standards for evaluating and rating the performance of firestop designs:
 - 1. ASTM E 814, Standard Method of Fire Tests of Through-Penetration Firestops.
 - 2. UL 1479, Fire Tests of Through-Penetration Firestops.
- C. Firestop design classification references:
 - 1. UL Fire Resistance Directory: Through-Penetration Firestop devices (XHCR) and Through-Penetration Firestop Systems (XHEZ).
 - 2. Factory Mutual Approval Guide.
 - 3. ULC List of Equipment and Materials, Vol. II.
 - 4. Other agencies or jurisdictional authorities which publish design performance or design evaluation services, e.g. CABO, BOCA, ICBO, SBCCI, Warnock Hersey, SwRI, shall be acceptable.

1.02 SCOPE OF WORK

- A. Perform all work required, and furnish all materials necessary to complete proper installation of firestops in fire rated walls and partitions, or fire rated floors, around penetrations of pipe, duct, cable, conduit and other electrical devices, or in blank openings, as indicated by the Drawings.
- B. Firestopping work shall be performed by a single installer or subcontractor to maintain consistency and accountability on the Project.

1.03 DEFINITIONS

- A. Fire Rated: Having the ability to withstand the effects of fire for a specified time period, as determined by qualified testing.
- B. Fire Rated Assembly: A floor, wall, or other partition able to withstand a design fire and hose stream test without failure.
- C. Fire Resistance Rating: The time, in hours, for which the rated assembly can withstand the effects of fire without burn-through or structural failure.
- D. Firestop: A means of sealing openings in fire rated assemblies to preserve or restore the fire resistance rating.
- E. Firestop System: The combination of materials and/or devices, including the penetrating items, required to make up a complete firestop.
- F. Penetrating Item: A pipe, duct, conduit, cable tray, cable, or other element passing through an opening in a fire rated assembly.

1.04 SUBMITTALS

- A. Submit manufacturer's technical data for each product which includes, at a minimum, product description, specification and storage requirements.
- B. Submit firestop design basis documents.
- C. Submit product installation procedures and requirements.
- D. Submit Materials Safety Data Sheets with product delivered to jobsite.

1.05 QUALITY ASSURANCE

- A. Workmanship:
 - 1. Installation shall conform to requirements of qualified design or manufacturer approved modification, as supported by engineering reports.
 - 2. Exposed surfaces of the firestop shall be finished to the standard of the adjacent faces of the partition being penetrated.

B. Regulatory Requirements:

1. Firestop systems shall be installed in all openings and around all penetrating elements or devices as required by these Specifications, and as required by applicable design, building and construction codes, subject to the interpretation of the authority having jurisdiction.

C. Certification:

1. The performance of the firestop designs shall have been demonstrated by third party testing in accordance with the applicable reference standards of Article 1.01. Evidence of third-party acceptance shall include labeling or listing by an acceptable agency.
2. Manufactured assemblies and material formulations shall be prepared under a third party monitored Quality Control Program, e.g., UL Followup Service.
3. Contractor shall certify compliance with the provisions of this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site in original unopened containers or bags bearing the name of the manufacturer, product name, type, grade and UL Classification Mark (or other acceptable approval or listing mark) where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
- C. Storage of products shall comply with manufacturer's requirements for each product.
- D. Comply with recommended procedures, precautions or remedies described in Material Safety Data sheets as applicable.

1.07 SEQUENCING AND SCHEDULING

- A. Firestopping requirements may be created by other trades under related sections of the Project Specification. Contractor shall:
 1. Identify all locations requiring firestopping.
 2. Schedule installation of firestopping after completion of duct, piping, electrical runs, but prior to covering or concealing of openings or eliminating access thereto.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Nelson Firestop Products, a Unit of General Signal.
- B. 3M Fire Protection Products
- C. Hilti Firestop Products
- D. Tremco, Inc.

2.02 MATERIALS

- A. Firestop material shall be a ready to use, permanently pliable intumescent putty, or caulk.
- B. Material shall have not less than a 2 hour fire rating.
- C. Technical requirements:
 1. Designs selected for installation shall provide a fire resistance rating at least equal to the hourly resistance rating of the wall or partition into which the firestop design will be installed.
 2. Firestop systems and materials shall not require special tools for installation and shall not emit hazardous, combustible or irritating fumes during installation, curing or use.
 3. When more than one firestop design is applicable, individual product characteristics should be evaluated for secondary benefits in performance, e.g. environmental/water sealing, or ease of installation or modification.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that all penetrating elements and supporting devices have been installed and all temporary lines have been removed.

3.02 PREPARATION

- A. Provide drop cloths or other satisfactory covering for protection of adjacent areas in accordance with good work practices.
- B. Surfaces which will be in contact with penetration seal materials shall be clean and free of dust, dirt, grease, oil, loose materials, rust or other substances.

3.03 INSTALLATION

- A. Install penetration seal materials in accordance with design requirements and manufacturer's instructions.
- B. Follow design requirements pertaining to cable separation.
- C. Follow manufacturer's recommendations to obtain a smooth, professional finish.
- D. If forms or damming materials are installed, they shall be removed after the designated cure time unless the support materials used are of a fire resistant or noncombustible nature.

3.04 REPAIRS AND MODIFICATIONS

- A. Identify damaged or re-entered seals requiring repair or modification.
- B. Remove loose or damaged materials.
- C. If penetrating elements are to be added, remove enough material to insert new elements, being careful not to cause damage to the balance of the seal.
- D. Insure that surfaces to be sealed are clean and dry.
- E. Install materials in accordance with Article 3.03 as required. Use only materials approved by manufacturer as suitable for repair of original seal.

3.05 FIELD QUALITY CONTROL

- A. Examine penetration seals for proper installation, adhesion and curing as may be appropriate for the respective seal materials.
- B. Keep areas of work accessible and notify code authorities or designated inspectors of work released for inspection.
- C. Document completion and inspection as required.

3.06 CLEAN-UP

- A. Remove equipment, materials, and debris, leaving area in a clean, undamaged condition.

END OF SECTION

SECTION 07 92 00 JOINT SEALANTS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Throughout the work, seal and caulk joints where shown on the Drawings and elsewhere as required to provide a positive barrier against passage of moisture and passage of air.
- B. Pre-Cast concrete wall shall be caulked full height of panel at both the interior and exterior face.

1.03 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary craft and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.04 SUBMITTALS

- A. Materials list of items proposed to be provided under this Section;
- B. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
- C. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.
- D. Samples: Accompanying the submittal described above, submit Samples of each sealant, each backing material, each primer, and each bond breaker proposed to be used.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original packaging with labels intact.
- B. Handle and store products in a manner to prevent damage.
- C. Do not retain at the job site material which has exceeded the shelf life recommended by its manufacturer.

PART 2 PRODUCTS

2.01 SEALANTS

- A. Except as specifically otherwise approved by the Architect, use only the types of sealants specified.
- B. Application and Sealant Required:
 - 1. Concrete sidewalk joints: Sonneborn, Sonolastic SL1 (one-part self-leveling polyurethane) or SL2 (two-part polyurethane sealant for horizontal joint); or Tremco Vulkem 45 SSL (one-part polyurethane).
 - 2. Joints between surface applied reglets and umbrella flashings and other materials: Sonneborn, Sonolastic NP 1 (one part) polyurethane; or Tremco Vulkem 116 (one-part polyurethane).
 - 3. Control joints in masonry: Sonneborn, Sonolastic 150, one part silyl-terminated non-sag elastomeric sealant.
 - 4. Interior perimeter joints between metal and/or hollow metal door and window frames and adjacent materials, and other joints indicated by drawings for caulk: Sonneborn, Sonolac (acrylic latex caulk); or Tremco Tremflex 834 (acrylic latex caulk).
 - 5. Exterior joints between metal items or between metal and masonry: Sonneborn, Omniseal (silicone sealant); or Tremco Spectrem 2 (silicone sealant).
- C. Colors for each sealant installation will be selected by the Architect from standard colors normally available from the specified manufacturers.
 - 1. In concealed installations, and in partially or fully exposed installations where so approved by Architect, use standard gray or black sealant.

2.02 PRIMERS

- A. Use only those primers which are non-staining, have been tested for durability on the surfaces to be sealed, and are specifically recommended for this installation by the manufacturer of the sealant used.

2.03 BACKER MATERIAL

- A. Use only those backer materials which are specifically recommended for this installation by the manufacturer of the sealant used, which are non-absorbent, and which are non-staining.
- B. Acceptable types include:
 - 1. Closed-cell resilient urethane or polyvinyl-chloride foam.
 - 2. Closed-cell polyethylene foam;
 - 3. Closed-cell sponge of vinyl or rubber;
 - 4. Polychloroprene tubes or beads;
 - 5. Polyisobutylene extrusions;
 - 6. Oil-less dry jute.

2.04 BOND-PREVENTATIVE MATERIALS

- A. Use only one of the following as best suited for the application, and as recommended by the manufacturer of the sealant used:
 - 1. Polyethylene tape, pressure-sensitive adhesive, with the adhesive required only to hold tape to the construction materials as indicated;
 - 2. Aluminum foil complying with MIL-A-148E;
 - 3. Wax paper complying with Fed Spec UU-P-270.

2.05 MASKING TAPE

- A. For masking around joints, provide masking tape complying with Fed Spec UU-T-106c.

2.06 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Concrete and masonry surfaces:
 - 1. Install only on surfaces which are dry, sound, and well brushed, wiping free from dust.
 - 2. At open joints, remove dust by mechanically blown compressed air if so required.
 - 3. Use solvent to remove oil and grease, wiping the surfaces with clean rags.
 - 4. Where surfaces have been treated, remove the surface treatment by sandblasting or wire brushing.
 - 5. Remove laitance and mortar from joint cavities.
 - 6. Where backup is required, insert the approved backer material into the joint cavity to the depth needed.
- B. Steel surfaces:
 - 1. Steel surfaces in contact with sealant:
 - a. Sandblast as required to achieve acceptable surface for bond.
 - b. If sandblasting is not practical, or would damage adjacent finish, scrape the metal or wire brush to remove mill scale.
 - c. Use solvent to remove oil and grease, wiping the surfaces with clean rags.
 - 2. Remove protective coatings on steel by sandblasting or by using a solvent which leaves no residue.

- C. Aluminum surfaces:
 - 1. Aluminum surfaces in contact with sealant:
 - a. Remove temporary protective coatings, dirt, oil and grease.
 - b. When masking tape is used for protective cover, apply the tape just prior to applying the sealant.
 - 2. Use only such solvents to remove protective coatings as are recommended for that purpose by the manufacturer of the aluminum work, and which are non-staining.

3.03 INSTALLATION OF BACKER MATERIAL

- A. Use only the backer material recommended by the manufacturer of the sealant used for the particular installation, compressing the backer material 25% to 50% to achieve a positive and secure fit.
- B. When using backer of tube or rod stock, avoid lengthwise stretching of the material. Do not twist or braid hose or rod backer stock.

3.04 PRIMING

- A. Use only the primer recommended by the manufacturer of the sealant for the particular installation, applying in strict accordance with the manufacturer's recommendations as approved by the Architect.

3.05 BOND-BREAKER INSTALLATION

- A. Install an approved bond-breaker where recommended by the manufacturer of the sealant adhering strictly to the installation recommendations as approved by the Architect.

3.06 INSTALLATION OF SEALANTS

- A. Prior to start of installation in each joint, verify the joint type according to details on the Drawings, or as otherwise directed by the Architect, and verify that the required proportion of width of joint to depth of joint has been secured.
- B. Equipment:
 - 1. Apply sealant under pressure with power-actuated or hand gun, or by other appropriate means.
 - 2. Use guns with nozzle of proper size, and providing sufficient pressure to completely fill the joints as designed.
- C. Thoroughly and completely mask joints where the appearance of sealant on adjacent surfaces would be objectionable.
- D. Install the sealant in strict accordance with the manufacturer's recommendations thoroughly filling joints to the recommended depth.
- E. Tool joints to the profile shown on the Drawings, or as otherwise required if such profiles are not shown on the Drawings.

3.07 CLEANING UP

- A. Remove masking tape immediately after joints have been tooled.
- B. Clean adjacent surfaces free from sealant as the installation progresses, using solvent or cleaning agent recommended by the manufacturer of the sealant used.

END OF SECTION

DIVISION 8 OPENINGS
SECTION 08 11 00 STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Furnish and install steel doors and frames as indicated on the Drawings.
- B. Related Sections:
 - 1. Section 08 70 00 - Hardware.
 - 2. Section 08 80 00 - Glazing.

1.03 SUBMITTALS

- A. Submit shop drawings and manufacturer's information on doors, frames, and hardware preparation.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store steel doors and frames under cover and protected from the weather.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Republic Steel Corporation
- B. Western Hollow Metal
- C. Amweld
- D. Mesker Door, Inc.
- E. Steelcraft
- F. Ceco

2.01 HOLLOW METAL DOORS

- A. Full-flush doors with flat and seamless steel face skins welded to internal steel channel stiles and rails, and with following requirements:
 - 1. Minimum thickness for face skins: 16 gauge.
 - 2. Insulating core for exterior doors: Structural foam.
 - 3. Cap doors, top and bottom, and weld. Fill and grind smooth all edge seams.
 - 4. Finish: Phosphatized and one coat rust-resisting baked-on prime paint.
 - 5. Mortise and reinforce for hardware.
 - 6. Glazed panels: As indicated on the Drawings.
 - 7. Cores for fire-rated doors: as required for labeling conditions.
 - 8. Label: Underwriters Lab Labels as required by the Door Schedule.

2.03 HOLLOW STEEL FRAMES

- A. Formed as indicated, with mitered and welded corners flush and smooth, and with the following requirements:
 - 1. Minimum gauge: 14 gauge.
 - 2. Finish: phosphatized and one coat rust-resistive baked-on prime paint.
 - 3. Mortise and reinforce for finish hardware. Cover hinge reinforcements and strike plate cutouts with plaster guard.
 - 4. Removable center mullion on pairs of doors where indicated. Astragals on pairs of doors and other special devices indicated or required.

5. Floor anchor and three (3) adjustable anchors per jamb for openings to 7'-2" high; additional anchors for taller frames.
6. Rubber silencer pads.
7. Provide sidelight, transom, and interior borrowed light frames with steel stops as shown on the Drawings.
8. Label: Underwriter's Lab Label as required by the Door Schedule.

2.04 HOLLOW METAL STEEL SEVERE WEATHER DOORS/FRAMES

- A. Frame: 14 gauge, hot-dipped galvanized steel.
- B. Door: 14 gauge, hot-dipped galvanized steel with polyurethane insulated core.
- C. UL certified to FEMA 320 & 361 2nd Edition standards.
- D. Paladin PW14 door/frame as manufactured by Steelcraft, Storm Pro severe weather door/frame & shutter/frame assembly as manufactured by Ceko or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install per approved shop drawings and manufacturer's directions.
- B. Frame spreaders at the base of hollow metal frames are usually provided only for stability during shipping. Do not rely on spreaders as a gauge of required door width.
- C. At all exterior locations, all concealed surfaces inside the frame shall be thoroughly covered with a coating of fibrated asphalt coating, prior to installation.

END OF SECTION

SECTION 08 14 00 WOOD DOORS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. ASTM E 90 - Measurement of Airborne Sound Transmission Loss of Building Partitions.
- C. ASTM E 152 - Methods of Fire Tests of Door Assemblies.
- D. ASTM E 413 - Classification for Determination of Sound Transmission Class.
- E. AWI - Quality Standards of the Architectural Woodwork Institute.
- F. Hardwood Plywood and Veneer Association, DFV-1-Voluntary Standard for Sliced Decorative Face Veneer.
- G. NFPA 80 - Fire Doors and Windows.
- H. NFPA 252 - Standard Method of Fire Tests for Door Assemblies.
- I. UL 10B - Fire Tests of Door Assemblies.

1.02 SECTION INCLUDES

- A. Wood doors; flush and flush glazed configuration; fire rated and non-rated.
- B. Related Sections:
 - 1. Section 08 11 00 - Steel Doors and Frames: Steel Frames.
 - 2. Section 08 70 00 - Hardware: Door Hardware.
 - 3. Section 08 80 00 - Glazing: Glass and Glazing.

1.03 SUBMITTALS

- A. Submit shop drawings that illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, and identify cutouts for glazing.
- B. Submit product data indicating door core materials and construction; veneer species, type and characteristics.

1.04 REGULATORY REQUIREMENTS

- A. Fire Door Construction: Conform to NFPA 252.
- B. Installed Door Assembly: Conform to NFPA 80 for fire rated class as indicated on Drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site in a manner that prevents damage and in accordance with manufacturer's instructions.
- B. Accept doors on site in manufacturer's standard packaging. Inspect for damage.
- C. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges if stored more than one week.
- D. Break seal on site to permit ventilation.

1.06 WARRANTY

- A. Provide manufacturer's warranty to the following term:
 - 1. Interior Solid Core Doors: **"LIFETIME"** including rehang and refinish if door(s) do not comply with specified tolerances. Furnish Owner, through Architect, with manufacturer's warranties for period required.
- B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Marshfield Door Systems, 5 ply doors, quality as defined in this Section.
- B. Other acceptable manufacturers:

1. Graham Manufacturing, 5 ply doors.
 2. Algoma Hardwoods, Inc., 5 ply doors.
 3. Lambton Doors, 5 ply doors.
 4. VT Industries, Inc., 5 ply doors.
 5. Marshfield Door System, 5 ply doors
- C. All doors shall be from the same manufacturer.

2.02 DOOR CORE CONSTRUCTION

- A. Core (Solid, Non-Rated): 28-32 lb. density, particleboard.
- B. Core (Solid, Fire Rated): 32 lb. density, particleboard, or mineral composition.
- C. Core (Hollow): Standard wood strip, grid interlocking, two lock blocks.
- D. Core (Acoustic): Two layers of high density particleboard with a center core of damping material.

2.03 DOOR FACING

- A. Veneer (Flush Interior Doors): AWI A grade red oak plain sliced with book matched grain, for transparent finish. Veneer shall conform to DFV-1.
- B. Vertical Exposed Edge of Stiles: Of same species as veneer facing.

2.04 ADHESIVES

- A. Facing Adhesive: Type I waterproof.

2.05 ACCESSORIES

- A. Glazing Stops (Rated and Non-Rated): Rolled steel; channel shape; mitered corners; prepared for countersink style screws.

2.06 FABRICATION

- A. Fabricate fire rated and non-rated doors in accordance with specified manufacturer's and ITS-WH and UL testing services. Attach fire rating label to the door.
- B. Provide flush doors with 1½" edge stiles of wood species to match face veneer.
- C. Sand bonded core prior to applying crossbanding and face veneers.
- D. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.
- E. Factory pre-fit doors for frame opening dimensions identified on shop drawings.
- F. Provide lock blocks at lock edge and top of door for closer for surface applied hardware reinforcement as per the hardware schedule.

2.07 FINISH

- A. Factory Finish
 1. Factory finish doors in accordance with AWI Quality Standards Section 1500. Factory finish to be water based stain and ultraviolet (UV) cured polyurethane sealer to comply with EPA Title 5 guidelines for Volatile Organic Compound (VOC) emissions limitations. Finish must meet or exceed performance standards of AWI TR-6 catalyzed polyurethane.
 2. Stain color and gloss to be selected by Architect from manufacturer's standard matching real wood species sample submittals.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that opening sizes and tolerances are acceptable.
- B. Do not install door in frame openings that are not plumb or are out of tolerance for size or alignment.

3.02 INSTALLATION

- A. Install fire rated doors in accordance with NFPA 80 and manufacturer's instructions.
- B. Install non-rated doors in accordance with manufacturer's instructions.

- C. Trim non-rated door width by cutting equally on both jamb edges.
- D. Trim door height by cutting bottom edges to a maximum of $\frac{3}{4}$ " (19 mm). Trim fire door height at bottom edge only, in accordance with fire rating requirements. Seal trimmed edge in accordance with Section 09 90 00.
- E. Pilot drill screw and bolt holes using templates provided.
- F. Coordinate installation of doors with installation of frames specified in Section 08 11 00 and hardware specified in Section 08 70 00.
- G. Coordinate installation of glass and glazing.

3.03 INSTALLATION TOLERANCES

- A. Maximum Diagonal Distortion (Warp): $\frac{1}{8}$ " measured with straight edge or taut string, corner to corner, over an imaginary 36 x 84 inch surface area.
- B. Maximum Vertical Distortion (Bow): $\frac{1}{8}$ " measured with straight edge or taut string, top to bottom, over an imaginary 36 x 84 inch surface area.
- C. Maximum Width Distortion (Cup): $\frac{1}{8}$ " measured with straight edge or taut string, edge to edge, over an imaginary 36 x 84 inch surface area.

3.04 ADJUSTING

- A. Adjust door for smooth and balanced door movement.

END OF SECTION

SECTION 08 36 00 - SECTIONAL OVERHEAD DOORS

PART 1 - GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Section Includes: **[Electrically]** operated sectional doors, operators, controls and accessories, as indicated on the Drawings.
- B. Related Sections:
 - 1. Division 5 Sections: Structural Steel & Metal Fabrications
 - 2. Division 26 Sections: Electrical connections and service for powered door operators.

1.03 REFERENCES

- A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A 924/A 924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance:
 - 1. Wind Loads: Uniform pressure of: 90 mph
- B. Spring Cycle Requirements: **[25,000]** cycles.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions.
- B. Shop Drawings: Provide drawings indicating track details, head and jamb conditions, spring shafts, anchorage, accessories, finish colors, patterns and textures, operator mounts and other related information.
- C. Samples: Submit selection and verification samples of metal finishes.
- D. Quality Assurance Submittals: Submit the following:
 - 1. Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.
 - 2. Certificates: Submit installer qualifications.
- E. Closeout Submittals: Submit the following:
 - 1. Warranty documents specified herein.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity, and trained and authorized by the door dealer to perform the work of this section.
- B. Schedule Preinstallation Meetings: To verify substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements.

1.07 DELIVERY, STORAGE & HANDLING

- A. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

- B. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1.08 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Furnish and install sectional overhead doors as manufactured by Raynor Door, Overhead Door, Wayne-Dalton, or approved equal.
- B. Manufacturer: Raynor Door.
 - 1. Contact: P.O. Box 448, 1101 East River Road, Dixon, IL 61021-0448; Telephone: (800) 472-9667, (815) 288-1431; Fax: (815) 288-7142; E-mail: thegarage@raynor.com; website: www.raynor.com.
- C. Manufacturer Product Designation: STYLEFORM OPTIMA.

2.02 DOOR OPERATORS

- A. Provide doors designed for **[electric motor]** operation.
- B. Manufacturer Product Designation: Raynor PowerHoist Standard (Model Series PHS).
 - 1. Type: **[Jackshaft]**
 - 2. Motor Horsepower Rating: Continuous **[1/2]** HP.
 - 3. Electrical Requirements: **[115 volt single]** phase.
 - 4. Duty Cycle: 30 cycles/hour.
 - 5. Control Wiring: Contactor Style Motor starter 24 volt control with provisions for connection of safety edge to reverse and external radio control hook-up. **[Three button momentary contact "open-close-stop" to control all doors for each elevation and interface with HVAC systems.** Solid State motor Controller 24 volt control with provisions to select up to 6 standard wiring types plus delay on reverse, mid stop, maximum run timer, and door lock feature.

2.03 DOOR SECTIONS

- A. Material: Steel sandwich construction, 2 inches (51mm) thick, roll formed from 25 gauge (0.015 inch) draw quality hot-dipped galvanized steel in compliance with ASTM A 924 and ASTM A 653 with woodgrain texture. Sections to be mechanically interlocked and pressure bonded to a 1-7/8 inches (48mm) thick non-CFC expanded polystyrene core and encased at each end with wrap-around type 18 gauge end stiles. Hinge reinforcement plates shall be 16 gauge galvanized steel, located within section interior at every hinge location. Provide embossed raised panels as follows: **[Ranch Raised Panel]**
- B. Mounting: Sections mounted in door opening using **[Lap Jamb Angle Mounting: section overlap door jambs by 1 inch (25mm) on each side of door opening]**
- C. Insulation: Sections will have an R-value of 10.25 and U-value of 0.097.
- D. Seals: Interior and exterior skins to be separated by a continuous dual durometer vinyl seal held in place by a mechanical interlock to form a thermal break and complete weatherseal along section joint. Bottom of door to have flexible U-shaped vinyl seal in an extruded aluminum retainer.
- E. Trussing: Doors designed to withstand specified windload. Deflection of door in horizontal position to be maximum of 1/120th of door width.
- F. Color and Paint Type: Interior and exterior skins to have two coats of paint, one primer coat and one finish coat. Exterior color: As selected by Architect. Interior color: White
- G. Windows: Manufacturer Window Type Designation: **[Ranch-type]** windows, encased in extruded PVC window frame. Locations to comply with door elevation drawings. Provide the following.
 - 1. Ranch-type window options:
 - a. **[Glass only].**

H. Glazing: ½ inch (12.69 mm) insulated glass consisting of two panes of 1/8 inch (3.2 mm) DSB insulated glass, clear @ interior and solar gray @ exterior.

2.04 TRACK

- A. Material: Hot-dipped galvanized steel (ASTM A-653), fully adjustable for adequate sealing of door to jamb or weatherseal.
- B. Configuration Type: **[Lift-Clearance]**
- C. Size: **[2 inches (51mm)]**
- D. Mounting: **[Floor-to-Header Angle-Mount consisting of continuous angle extending from the floor up to the door header for use with steel, wood, or masonry jambs. Continuous angle size not less than 2-5/16 inches by 4 inches by 3/32 inch (59 by 102 by 2.5mm)]**
- E. Finish: **[Galvanized]**

2.05 COUNTERBALANCE SYSTEM

- A. Type: Provided with aircraft-type, galvanized steel lifting cables with minimum safety factor of 5 to 1. **[Torsion Springs consisting of heavy-duty oil-tempered wire torsion springs on a continuous ball-bearing cross-header shaft]**

2.06 HARDWARE

- A. Hinges and Brackets: Fabricated from galvanized steel.
- B. Track Rollers: **[2 inches (50.8mm)]** diameter consistent with track size, with hardened steel ball bearings.
- C. Perimeter Seal: Provide perimeter seal for jambs and climate seal for the header.
- D. Air Infiltration Seal: Vinyl bulb air infiltration seal between door sections is provided.
- E. Locks: Furnish door system with **[interior lock with dead bolt provided with hole to receive padlock provided by owner]**.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Comply with instructions and recommendations of door manufacturer.

3.02 EXAMINATION

- A. Site Verification of Conditions: Verify through direct observation and field measurement that site conditions are acceptable for installation of doors, operators, controls and accessories. Ensure that openings square, flush and plumb.
- B. Do not proceed with installation of doors, operators, controls and accessories until unacceptable conditions are corrected.

3.03 INSTALLATION

- A. General: Install door, track and operating equipment complete with all necessary accessories and hardware according to shop drawings, manufacturer's instructions.

3.04 ADJUSTING

- A. General: Lubricate bearings and sliding parts, assure weathertight fit around door perimeter and adjust doors for proper operation, balance, clearance and similar requirements.

3.05 CLEANING

- A. Remove temporary coverings and protection of adjacent work areas. Repair or replace installed products damaged prior to or during installation.
- B. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Remove and legally dispose of construction debris from project site.

END OF SECTION

SECTION 08 41 00 ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Work Included: Provide all necessary materials, labor, and equipment for the complete installation of aluminum swinging doors and aluminum door, sidelight and transom frames as shown on the Drawings and specified herein.
- B. Work Not Included: Structural support of the framing system, interior closures, trim, metal sub-sill.
- C. Related Work Specified Elsewhere:
 - 1. Section 07 92 00 Joint Sealants
 - 2. Section 08 80 00 Glazing

1.03 QUALITY ASSURANCE

- A. Drawings and Specifications are based upon the Series 350 medium stile doors, the TRIFAB VG451 frame system at interior installations and 451 T frame system at exterior installations, as manufactured by the Kawneer Company, Inc., or approved equal. Whenever substitutes are to be proposed, supporting technical literature, samples, drawings, and performance data must be submitted ten (10) days prior to bid in order to make a valid comparison of the product involved. Test reports certified by an independent test laboratory must be made available upon request. Entrance doors and framing systems shall be the product of a single manufacturer.
- B. Performance Requirements (Doors):
 - 1. Structural: Resistance to corner racking shall be tested by the Dual Moment Load test as follows:
 - a. Test section shall consist of a standard top door corner assembly. Side rail section shall be 24" long and top rail section shall be 12" long.
 - b. Anchor "top rail" positively to test bench so that corner protrudes 3" beyond bench edge.
 - c. Anchor a lever arm positively to "side rail" at a point 19" from inside edge of "top rail". Attach weight support pad at a point 19" from inner edge of "side rail".
 - d. Test section shall withstand a load of 270 lbs. on the lever arm before reaching the point of failure, which shall be considered a rotation of the lever arm in excess of 45 degrees.
 - 2. Air Infiltration: Air infiltration shall be tested in accordance with ASTM E 283, at a pressure differential of 1.567 P.S.F. (75 Pa.). A single 3'-0" x 7'-0" (914.4 x 2133.6) entrance door and frame shall not exceed 0.50 CFM per linear foot of perimeter crack. A pair of 6'-0" x 7'-0" (1828.8 x 2133.6) entrance doors and frame shall not exceed 1.0 CFM per linear foot of perimeter crack.
- C. Performance Requirements (Storefront Frames):
 - 1. Structural performance shall be based on: Maximum deflection of 1/175 of the span and allowable stress with a safety factor of 1.65. The system shall perform to these criteria in conformance with the following:
 - a. Code: International Building Code, 2000 Edition.
 - b. Wind Speed = 90 MPH
 - 2. Air infiltration shall be tested in accordance with ASTM E 283. Infiltration shall not exceed .06 CFM per square foot (.0003 m/sm) of fixed area.
 - 3. Water infiltration shall be tested in accordance with ASTM E 331. No water penetration at a test pressure of 8 PSF.
- D. Installer Qualifications: Installer shall be a company specializing in installation of aluminum storefront glazing systems with a minimum of three (3) years of documented experience.

1.04 SUBMITTALS

- A. Submit product data for each type of product specified.
- B. Submit shop drawings showing layout, profiles, and product components, including anchorage, accessories, finish colors and textures.

1.05 SITE CONDITIONS

- A. Verify dimensions of openings by field measurements before fabrication. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Doors: Extrusions shall be 6063-T5 alloy tempered (ASTM B 221 alloy G. S. 10A-T5). Fasteners, where exposed, shall be aluminum, stainless steel or plated steel in accordance with ASTM A 164. Perimeter anchors shall be aluminum or steel, providing the steel is properly isolated from the aluminum. Glazing gaskets shall be EPDM elastomeric extrusions. Major portions of the door stiles shall be 0.125" (3.2) nominal in thickness and glazing molding shall be 0.050" (1.2) thick.
- B. 451 Frames: Extrusions shall be 6063-T5 alloy and tempered (ASTM B 221 alloy G. S. 10A-T5). Fasteners, where exposed, shall be aluminum, stainless steel or plated steel in accordance with ASTM A 164. Perimeter anchors shall be aluminum or steel, providing the steel is properly isolated from the aluminum. Glazing gaskets shall be elastomeric extrusions.
- C. 451T Frames: Extrusions shall be 6063-T5 alloy and tempered (ASTM B 221 alloy G. S. 10A-T5). The thermal barrier shall consist of a two-part, chemically curing, high density polyurethane. Fasteners, where exposed, shall be aluminum, stainless steel or plated steel in accordance with ASTM A 164. Perimeter anchors shall be aluminum or steel, providing the steel is properly isolated from the aluminum. Glazing gaskets shall be elastomeric extrusions.
- D. Finish: All exposed framing surfaces shall be free of scratches and other serious blemishes. Aluminum molding shall be given a caustic etch followed by an anodic oxide treatment to obtain an Architectural Class II Anodic Coating conforming to Aluminum Association Standard AA-M12C22A31, No. 40 DARK BRONZE.

2.02 FABRICATION

- A. Doors: The door stile and the rail face dimensions of the 350 entrance door will be as follows: Vertical Stile = 3-½"; Top Rail = 3-½" and Bottom Rail = 10". Corner construction shall consist of mechanical clip fastening, SIGMA deep penetration and fillet welds. Glazing stops shall be hook-in type with EPDM glazing gaskets. The meeting stiles on pairs of doors shall be equipped with an adjustable astragal.
- B. Framing: The framing system shall provide for flush glazing on all sides with no projecting stops. Vertical and horizontal framing members shall have nominal face dimensions of 2" (50.8 mm) or 4" (101.6 mm) as detailed. Overall depth shall be 4-½" (114.3 mm). Entrance framing members shall be compatible with glass framing in appearance. All single acting entrance frames shall include the Sealair positive barrier weathering.

2.03 HARDWARE

- A. Entry and Vestibule Doors:
 - 1. Hardware required each door:
 - a. Kawneer, Paneline CR-90 concealed rod exit device with crossrail to match door finish and push panel clear anodized, with style CNP pull x US32 finish.
 - b. LCN #4111 H-CUSH with Blade Stop 4110-61 and Shoe Support 4110-30 with hold open closer & factory applied powder coat to match #17 finish.
 - c. Continuous gear hinge.
 - d. Infill for glazing as scheduled on Drawings.
 - e. Sealair Weathering System for exterior doors.
 - f. ½" x 4" aluminum finish threshold at exterior doors.
 - g. Cylinder locks keyed to building system by others (see Hardware Schedule).

PART 3 EXECUTION

3.01 INSTALLATION

- A. All glass and panel framing shall be set in correct locations as shown in the details and shall be level, square, plumb, and in alignment with other work in accordance with the manufacturer's installation instruction and approved shop drawings. All joints between framing and the building structure shall be sealed in order to secure a watertight installation.

3.02 PROTECTION

- A. After installation the Contractor shall adequately protect exposed portions of aluminum surfaces from damage by grinding and polishing compounds, plaster, lime, acid, cement, or other contaminants.

END OF SECTION

SECTION 08 70 00 HARDWARE

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. The intent of this Section is to provide finish hardware for the proper operation and control of all wood and metal doors in the project. Prior to bidding, notify the Architect of any doors that do not have hardware meeting this intention.

1.03 SUBMITTALS

- A. Hardware Schedule: Submit a hardware schedule in a vertical format (horizontal format not acceptable), organized into sets, including the information below.
 - 1. Type, style, function, size and finish of each hardware item.
 - 2. Name and manufacturer of each item.
 - 3. Fastenings and other pertinent information.
 - 4. Explanation of all abbreviations, symbols, codes, etc., contained in schedule.
 - 5. Mounting locations for hardware.
 - 6. Door and frame sizes and materials.
 - 7. Catalog cut sheets describing and showing each piece of hardware scheduled.
- B. Submittal Sequence: Submit schedule at earliest possible date, particularly where acceptance of hardware schedule must precede fabrication of other work (e.g., hollow metal frames) which is critical in the project construction schedule.
- C. Keying Schedule: Coordinate keying requirements with Architect prior to submitting Hardware Schedule. Keying schedule must be approved before ordering any locks.
- D. Templates: Furnish hardware templates and copy of approved schedule to Hollow Metal and Wood Door suppliers.

1.04 QUALITY ASSURANCE

- A. Manufacturer: Obtain each type of hardware (latch and lock sets, hinges, closer, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.
- B. Supplier Qualifications: A recognized architectural finish hardware supplier, with warehousing facilities, who has been furnishing hardware in the project's vicinity for a period of not less than two (2) years, and who is, or who employs an experienced architectural hardware consultant who is available, at reasonable times during the course of the work, for consultation about project's hardware requirements, to Owner, Architect, and Contractor.
- C. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80 and local building code requirements. Provide only hardware which has been tested and listed by UL or FM for types and sizes of doors required and complies with requirements of door and door frame labels.
 - 1. Where emergency exit devices are required on fire-rated doors, (with supplementary marking on doors' UL or FM labels indicated "Fire Door to be Equipped with Fire Exit Hardware:) provide UL or FM label on exit devices indicating "Fire Exit Hardware".

1.05 DELIVERY, STORAGE AND HANDLING

- A. Pack each hardware item in separate containers with all screws, wrenches, installation instructions and installation templates, mark each box with hardware heading and door number according to approved hardware schedule.
- B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation. Provide a complete packing list showing items, door numbers and hardware headings with each shipment.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR HARDWARE

- A. Provide the materials or products indicated by trade names, manufacturer's name, or catalog number. Substitutions will be permitted only with the approval of the Architect.
- B. Provide manufacturer's standard products meeting the design intent of this Specification, free of imperfections affecting appearance of serviceability.
 - 1. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
 - 2. Hand of Door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
 - 3. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels and as otherwise acceptable to Architect.
 - a. Manufacturer's identification will be permitted on rim of lock cylinders only.
 - 4. Furnish screws for installation, with each hardware item. Provide Phillips flat-head screws except as otherwise indicated or approved. Finish screws exposed under any condition to match hardware finish or, if exposed in surfaces of other work, to match finish of such other work as closely as possible. Use machine screws for metal connections and wood screws for connections to wood.
 - 5. Provide concealed fasteners for hardware units which are exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work, except where indicated otherwise or where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.
- C. Hardware is specified in the hardware schedule by set, type, and functions which have been selected as best meeting the application requirements.

2.02 SPECIAL REQUIREMENTS

- A. Hinges: Provide non-removable pins for all exterior doors. Use non-rising pins for all other doors.
- B. Closers:
 - 1. Comply with manufacturer's recommendations for unit size based on door size, weather exposure and usage.
 - 2. Where parallel arms are indicated, provide closer one size larger than recommended for use with standard arms.
 - 3. Provide parallel arms for all overhead closers, except as otherwise indicated.
 - 4. Through-bolt all closer units.
 - 5. All closers shall be ADAAG compliant.
- C. Panic Devices:
 - 1. All panic devices shall be through-bolted.
 - 2. Except on fire-rated doors, provide panic devices with dogging device to hold latch bolt open on doors with closers.

2.03 KEYING

- A. Contractor shall match the keying in the existing Schlage Master Key system.

2.04 HARDWARE FINISHES

- A. Provide matching finishes for hardware units at each door to the greatest extent possible, unless otherwise indicated. In general, match items to the finish for the latch, lock or push-pull unit for color and texture.
- B. Thresholds: Clear, anodized aluminum.
- C. Kickplates and Perimeter Seals: As indicated or scheduled.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install hardware using templates furnished by the manufacturer.
- B. Protect prefinished doors from damage to finished surfaces during installation.

3.02 ADJUSTING

- A. Adjust hardware to provide positive and secure latching and locking.
- B. Adjust hardware to provide smooth, balanced operation.
- C. Adjust closers to require no more than the maximum opening force allowed in accordance with ADA Guidelines.

3.03 HARDWARE PRODUCTS

A. Hinges, Template, Full Mortise, 5-Knuckle, Ball-Bearing, 4½ x 4½:

	<u>Hager</u>	<u>Stanley</u>	<u>McKinney</u>
1. Heavy-weight, nonferrous, NRP	BB1199	FBB199	TB43386
2. Standard weight, nonferrous, NRP	BB1191	FBB191	TB2314
3. Heavy-weight, steel	BB1168	FBB168	T4B3786
4. Standard weight, steel	BB1279	FBB179	TB2714

B. Hinges, Template, Full Mortise, 5-Knuckle, Plain Bearing, 4½ x 4½:

	<u>Hager</u>	<u>Stanley</u>	<u>McKinney</u>
1. Standard weight, nonferrous, NRP	1191	F191	T2314
2. Standard weight, steel	1279	F179	T2714

C. Hinges, Template, Full Mortise, Spring, 4½ x 4½:

	<u>Hager</u>	<u>Stanley</u>	<u>McKinney</u>	<u>Bommer</u>
1. Standard weight	1250	2060	1502	4310

D. Pivots:

	<u>Hager</u>	<u>Stanley</u>	<u>McKinney</u>
1. Emergency, double-acting	510	DAP-3	EP-5

E. Locksets, Cylindrical, Heavy-duty:

	<u>Schlage</u>	<u>Yale</u>	<u>Corbin Russwin</u>	<u>Cal-Royal</u>
1. Entry (ANSI F82)	AL53PD-RHO	5307LN-AU	CL3851-NZD	SL-00
2. Classroom (ANSI F84)	AL70PD-RHO	5308LN-AU	CL3855-NZD	SL-03
3. Storeroom (ANSI F86)	AL80PD-RHO	5305LN-AU	CL3857-NZD	SL-05
4. Privacy (ANSI F76)	AL40S-RHO	5301LN-AU	CL3820-NZD	SL-20
5. Passage (ANSI F75)	AL10S-RHO	5301LN-AU	CL3810-NZD	SL-30

F. Lock Cylinders: Single cylinder keyed as required to fit locking devices provided under other headings or sections:

1. Keyed one (1) side.
2. Keyed two (2) sides.

G. Panic Devices: Von Duprin – 996 series

H.	<u>Door Bolts:</u>				
		<u>Ives</u>	<u>Quality</u>	<u>Rockwood</u>	<u>Hager</u>
1.	Flush, manual, mount 12" above/below edge metal door	458	1358	555	282D
2.	Flush, manual, wood door	- - -	N/A	557	283D
3.	Flush, automatic, w/dust proof strike, rated metal doors	559 487/489	N/A	1842/1880	292D/280X
4.	Flush, automatic, w/dust proof strike, rated wood doors	559 487/489	N/A	1942/1880	291D/280X
5.	Surface bolt 1" long	40	B	N/A	278
I.	<u>Coordinator:</u>				
		<u>Ives</u>	<u>Quality</u>	<u>Rockwood</u>	<u>Hager</u>
1.	Conventional type	469	- - -	576	298D
J.	<u>Closers:</u> LCN 4010/4110 Series				
K.	<u>Operating Trim:</u>				
		<u>Rockwood</u>	<u>Quality</u>	<u>Hager</u>	
1.	Push plate, B4E, .050, 4" x 16"	70C	40-5	30S (4x16)	
2.	Pull w/plate, B4E, .050, round bar grip ¾" x 8" x 4" x 16"	BF107x70C	1610A-5 2½" clearance	33G (4x16) 2½" clearance	
L.	<u>Kickplates, 8" x 2" LDW, countersink x oval head screws:</u>				
1.	Stainless steel, US32D x .050				
2.	Satin bronze, US10				
3.	Clear plastic x ⅛" x B4E				
4.	Dark brown plastic x ⅛" x B4E				
M.	<u>Stop/Holders:</u>				
		<u>Rockwood</u>	<u>Quality</u>	<u>Ives</u>	<u>Hager</u>
1.	Floor stop/holder, heavy cast	485	419ES	- - -	258F
2.	Floor stop, heavy cast	483	119ES	442	252F
3.	Floor stop, low cast dome type	440	331	436	241F
4.	Floor stop, high cast dome typ	442	431	438	243F
5.	Wall stop, wrought, concave bumper	409	W302TB	407½	236W
6.	Wall stop, wrought, convex bumper	406	W307TB	407	232W

7.	Hinge stop, wrought steel adjustable	---	---	69	---
N.	<u>Emergency Door Stop:</u>				
		<u>McKinney</u>	<u>Stanley</u>	<u>Hagar</u>	
1.	Emergency stop with double lip strike	C559	ESI/DLS2	610/451	
O.	<u>Thresholds & Gasketing:</u>				
		<u>Pemko</u>	<u>Reese</u>	<u>Hagar</u>	<u>National Guard</u>
1.	Threshold, alum. 1/2" x 5" w/stop strip H/C	2005AV	S483AV	520SV	896V
2.	Threshold, alum. 1" x 5" w/stop strip	181AV	S488AV	5755V	803V
3.	Threshold alum. 1/4" x 5", H/C	271A	S405A	413S	513
4.	Threshold alum. 1/2" x 5", H/C	171A	S205A	412S	425E
5.	Weatherstrip, alum., head & jamb	316AV	DS75A	890S	152
6.	Gasketing, head & jamb, smoke	PK55D	---	736	2525
7.	Sweep, alum., smoke	307AV	806A	756SV	97V
8.	Drip cap, alum. 9/16" projection	345A	R199A	---	17D
9.	Drip cap, alum. 2 1/2" projection	346C	R201C	810S	16AD
10.	Automatic door bottom, alum., surface mount	412C	320C	740S	220
P.	Abbreviations of manufacturer names:				
1.	H	Hager (Approved Equals: Stanley, McKinney)			
2.	LCN	LCN (Approved Equals: Norton, Yale)			
3.	S	Schlage (Approved Equals: Corbin-Russwin, Yale, Cal-Royal)			
4.	R	Rockwood (Approved Equals: Pemko, Quality)			
5.	P	Pemko (Approved Equals: Reese, National Guard)			
6.	D	Dorma			

3.04 SCHEDULE

Set 1

Doors: 1, 5, 7, 8, 9, 11, 17, 18, 26

Each opening to receive:

1	Cylinder 20-013/20-022 x 626 as required	S
	Remaining hardware by door supplier	
1	Magnetic Lock (Door 26 ONLY)	D
	EML 310TP LX x 628	
	(Rectifier located in Room 102)	

Set 2

Doors: 12, 13, 16, 19, 20, 21, 22

WD x HMF (12, 13)

HMD x HMF (16, 19, 20, 21, 22)

Each opening to receive:

3	Hinges BB1191 x 626D x 4½ x 4½ x NRP	H
1	Lock AL53PD – RHO x 626	S
1	Kickplate 8 x 34 x 626D	R
1	Set W/S 303 Av x 1/36 x 2/86	P
1	Stop 483 x 626D	R

Set 3

Doors: 23

WD x HMF

Each opening to receive:

3	Hinges BB1279 x 26D x 4½ x 4½	H
1	Passage AL10S - RHO	S
1	Kickplate 8 x 34 x 32D	R
1	Stop 409 x 32D	R
1	Closer 4111-EDA x 32D	LCN

Set 4

Doors: 24, 25

HMD x HMF (24)

WD x HMF (25)

Each opening to receive:

6	Hinges BB T4B3786 x 26D x 1 4 ½ x 4 ½	Mc
2	Closer 4111-EDA x SNB 689	LCN
2	Panic 99-L-2 (handed) x 32D x SNB	VD
1	Keyed Removable Mullion KR 9954	VD
2	Core (Doors)	S
1	Core (Mullion)	S
2	Kickplate 8 x 34 x 32D	R
1	Set W/S PK55D x 20'	P

Set 5

Door: 14, 15

Each Opening to receive:

WD x HMF

6	Hinges BB1279 x 25D x 4 ½ x 4 ½	H
2	Kickplate 8 x 34 x 32D	R
2	Stop 409 x 32D	R
2	Push Plate 70C .050 x 4" x 16" x 626	R
2	Pull w/ Plate & Round Bar BF107 x 70C x 626	R

Set 6

Doors: 2, 3

HMD x HMF

Each Opening to Receive:

6	Hinges BB1191 x 626d x 4½ x 4½ x NRP	Mc
1	Lock AL53PD – RHO x 626	S
2	Closer 4111-EDA x SNB 689 w/ Hold Open Function	LCN
2	Kickplate K1050 8" x 2" LDW US32D	RO
2	Exterior Stop 483US26D	RO
2	Weather Seal S88 D (Head & Jambs)	P
1	Drip Cap 346 C x Frame Width	P
2	Drip Brush Sweep 345 ANB x Door Width	P
1	ASA Threshold 271 A x Opening Width	P
1	Flush Bolt	P

Set 7

NOT USED

Set 8

Doors: 4, 6, 10

Each Opening to Receive:

HMD x HMF

3	Hinges BB1191 x 626D x 4½ x 4½ x NRP	H
1	Lock AL53PD – RHO x 626	S
1	Kickplate 8 x 34 x 626D	R
1	Threshold 171A x 36"	P
1	Door Sweep 315CN x 36"	P
1	Set W/S 303 Av x 1/36 x 2/86	P
1	Stop 483 x 626D	R
1	Drip 345A DW + 4"	R
1	Closer 4111-EDA x 32D x SNB	LCN

END OF SECTION

SECTION 08 80 00 GLAZING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. Flat Glass Marketing Association:
 - 1. Glazing Manual.
 - 2. Glazing Sealing System Manual.

1.02 SUMMARY

- A. Provide glazing and glazing accessories where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

1.03 SUBMITTALS

- A. Submit product data as follows:
 - 1. Materials list of items proposed to be provided under this Section;
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
 - 3. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.
- B. Samples: Accompanying the above product data, submit:
 - 1. Samples of each type of glass and gasket proposed to be used;
 - 2. Samples, at least 12" long, of each type of sealant proposed to be used, installed between samples of the material to be glazed, fully cured.

1.04 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. During storage and handling of glass, provide cushions at edges to prevent impact damage.

PART 2 PRODUCTS

2.01 GLASS

- A. General:
 - 1. For all glass, provide the type and thickness shown on the Drawings or specified herein.
 - 2. Where type or thickness, or both, are not shown on the Drawings or specified herein, provide type and thickness directed by the Architect.
- B. Plate or Float Glass: Comply with Fed Spec DD-G-451, Type I, Class 1, Quality q3.2. Where plate glass is called for, plate glass or float glass may be used.
- C. Sheet Glass: Provide Type II, Class 1, Quality q5.
- D. Tempered Glass:
 - 1. Provide tempered or heat-strengthened glass where indicated on the Drawings, and elsewhere as required by governmental agencies having jurisdiction.
 - 2. Glass for Tempering:
 - a. For plate glass or float glass, use Type I, Class 1, Quality q3.
 - b. For heat absorbing glass, if required, use Type I, Class 2, Type B, in color as shown on the Drawings or otherwise selected by the Architect.
 - 3. Sizes and Cutting:
 - a. Prior to tempering or heat treating, cut glass to required sizes as determined by accurate measurements of the openings to be glazed, making allowances for required edge clearances.
 - b. Cut and process edges in accordance with the glass manufacturer's recommendations.
 - c. Do not cut or treat edges in the field.
 - 4. Fully Tempered Glass:

- a. Comply with Fed Spec DD-G-1403 and ANSI Z97.1.
 - b. Wherever possible, locate tong marks along an edge which will be concealed in the glazing system.
 - c. Permit minimum warpage practicable.
- 5. Heat-strengthened Glass:
 - a. Comply with Fed Spec DD-G-1403.
 - b. Strengthen by the manufacturer's standard heat-treating process, increasing flexural strength to not less than twice the strength before treatment.
 - c. Permit minimum warpage practicable.
- E. Specific Glass Types:
 - 1. Insulating Tinted:
 - a. 1" insulating glass composed of 1/4" PPG Solar gray at exterior and 1/4" clear at interior.
 - b. Aesthetic appearance: LIGHT GRAY
 - c. Performance:

Transmittance, total solar energy	33%
U-Value, Winter Night	.48
U-Value, Summer Day	.57
Shading Coefficient	.52
Solar Heat Gain Coefficient	.45
Tempered as required	
 - 2. 1/4" tempered clear glass (typical at interior aluminum doors and sidelights at vestibules).
 - 3. 1/4" Clear Plate (typical at interior doors).
 - 4. 1/4" Fire Glass shall be Firelite Plus by Hippon Electric Glass, or approved equal.
 - 5. 1/4" Mirror shall be mechanically attached w/ all edges ground smooth.

2.02 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Examine the areas and surface conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.
- B. Clean glazing channels, stops, and rabbets to receive the glazing materials, making free from obstruction and deleterious substances which might impair the work.
 - 1. Remove protective coating which might fail in adhesion or interfere with bond of sealants.
 - 2. Comply with manufacturer's instructions for final wiping of surfaces immediately prior to application of primer and glazing compounds or tapes.
 - 3. Prime surfaces to receive glazing compounds in accordance with manufacturer's recommendations.

3.02 INSTALLATION

- A. Inspect each piece of glass immediately prior to start of installation.
 - 1. Do not install items which are improperly sized, have damaged edges, or are scratched, abraded, or damaged in any other manner.
 - 2. Do not remove labels from glass until so directed by the Architect.
- B. Locate setting blocks at sills one quarter of the width of the glass in from each end of the glass, unless otherwise recommended by the glass manufacturer.
 - 1. Use blocks of proper size to support the glass in accordance with the manufacturer's recommendations.
 - 2. Provide spacers for all glass sizes larger than 50 united inches, to separate glass from stops; except where continuous glazing gaskets or felts are provided.
 - a. Locate spacers no more than 24" apart, and no closer than 12" to a corner.
 - b. Place spacers opposite one another.
 - c. Make bite of spacer on glass 1/4" or more.
- C. Set glass in a manner which produces the greatest possible degree of uniformity in appearance.

- D. Do not use two different glazing materials in the same joint system unless the joint used is approved in advance by the Architect.
- E. Mask, or otherwise protect, surfaces adjacent to installation of sealants.
- F. Miter-cut and seal the joints of glazing gaskets in accordance with the manufacturer's recommendations, to provide watertight and airtight seal at corners and other locations where joints are required.

3.03 PROTECTION

- A. Protect glass from breakage after installation by promptly installing streamers or ribbons, suitably attached to the framing and held free from glass. Do not apply warning markings, streamers, ribbons, or other items directly to the glass except as specifically directed by the Architect.

END OF SECTION

DIVISION 9 FINISHES
SECTION 09 21 16 GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Furnish and install gypsum drywall assemblies for interior finishing and related items required to complete the work indicated on the Drawings and herein specified, or both.

1.03 SUBMITTALS

- A. Submit a one foot long sample of each casing bead, "L" bead, expansion joint, bull nose corner bead, and corner bead for approval.
- B. Submit manufacturer's data for each type of gypsum board.

1.04 QUALITY ASSURANCE

- A. The Contractor shall coordinate the work between the trades to insure compliance with the Specifications, and to permit orderly and expeditious procedure in executing the work.
- B. Workmanship: Installation and taping of drywall interior finish shall be done by qualified mechanics experienced in this craft and capable of rendering a satisfactory installation in every respect.
- C. Temperature Requirements:
 - 1. If gypsum wall board is installed in the winter, heat not less than 60° F shall be maintained in the structures at all times.
 - 2. Temperature shall be maintained during installation of board as well as during the taping process.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original packages or bundles with name of manufacturer, type of material, and sizes clearly marked on the packaging and containers.
- B. Store materials above the ground, protected from the weather.

PART 2 PRODUCTS

2.01 MATERIALS

- A. In exposed locations wall board shall be fire-rated type X panels 5/8 inch thick x 48 inches wide as manufactured by U.S. Gypsum Company, Temple-Inland Forest Products Corporation, National Gypsum Company, or approved equal.
- B. Gypsum wall board in locations above ceilings shall be fire rated type X in thickness as detailed on Drawings x 48 inches wide with tapered edges as manufactured by U.S. Gypsum Company, Temple-Inland Forest Products Corporation, National Gypsum Company, or approved equal.
- C. Tape shall be cross-fibered, with chamfered edges feather thin, as recommended by the gypsum wall board manufacturer.
- D. Joint cement and topping cement shall be that approved product manufactured by, and recommended by, the gypsum wall board manufacturer.
- E. Fasteners: U. S. G. Type S Bugle Head screws or approved equal.
- F. Adhesive for direct applications shall be per gypsum wall board manufacturer's recommendations.
- G. "MJ" casing beads, "L" beads, expansion joints, bull nose corner beads and corner beads shall be rigid PVC as manufactured by Alabama Metal Industries Corporation (800-366-2642) or approved equal.
- H. Control Joint: Roll formed zinc with perforated flanges USG #093 or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. The Contractor shall examine the framing to which the gypsum board is to be applied. If any defects in alignment or blocking are noted which would not allow the installation of the gypsum board as set forth in the Specifications, the defects shall be corrected before the gypsum board installation is started. Commencement of work on the framing constitutes acceptance of the framing by the Contractor.

3.02 GYPSUM BOARD INSTALLATION

- A. To minimize end joints, use wall board of maximum practical length. End joints shall be staggered.
- B. Provide PVC edge trim where wall board edge abuts dissimilar material.
- C. All flat joints shall be reinforced with tape, cemented with joint cement and finished with topping cement as recommended by gypsum board manufacturer, to a smooth, invisible joint.
- D. Where joints are not exposed to view, all flat joints shall be reinforced with tape and cemented with joint cement (Fire Taped), or UL listed adhesive fire tape.
- E. All screws shall be slightly set and covered with topping cement so as to become invisible.
- F. Corners shall be constructed as follows unless otherwise shown on the Drawings.
 - 1. Inside corners shall be reinforced with tape folded to conform to adjoining surface to form straight true angle.
 - 2. Outside corners shall have PVC corner bead. PVC corner bead shall be concealed by at least two coats of compound.
- G. No cracked boards shall be accepted in any case. Boards with occasional marred surface or edge may be allowed, if in the judgment of the Architect, these boards can be patched with compound.
- H. After final coat of topping compound has dried, sand lightly to produce smooth finished surface. Final finish by spray application of a light orange peel texture in areas scheduled to be painted.
- I. All ends of gypsum wall board shall occur over studs, joists, furring channels, or other firm support.
- J. Do not exceed 1/8 inch in 8'-0" variation from plumb or level. Shim as required to comply with tolerances.
- K. Install control joints at junction of gypsum board partitions or other finish material. Install control joints in long runs of partitions, ceilings or soffets at approximately 30' on center.

3.03 CLEAN-UP

- A. At the completion of the work, all areas shall be left in a clean and neat manner with debris removed. All stains and other foreign matter shall be cleaned from floors, trim, walls, and ceiling. All areas shall be left ready for painting.

END OF SECTION

SECTION 09 30 00 TILE

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. American National Standards Institute (ANSI):
 - 1. ANSI A 108.5-1992 Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
 - 2. ANSI A 108.10-1992 Installation of Grout in Tilework.
 - 3. ANSI A 118.4-1992 Latex-Portland Cement Mortar.
 - 4. ANSI A 118.6-1992 Ceramic Tile Grouts.
 - 5. ANSI A 137.1-1988 Ceramic Tile.
- C. Tile Council of America, Inc. (TCA): 1997 Handbook for Ceramic Tile Installation (35th Edition).

1.02 SUMMARY

- A. Furnish and install interior ceramic wall tile as indicated on the Drawings.
- B. Furnish and install ceramic floor tile and bases as indicated on the Drawings.
- C. Include materials for mortar bases, grout, and other necessary items for a complete installation.

1.03 SUBMITTALS

- A. Submit samples indicating all available colors for approval and color selection before placing orders for material.
- B. Submit a master grade certificate stating grade, kind of tile, identification marks for tile packages, name and location of project, and signature of authorized representative of the tile manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials in manufacturer's original packaging with seals unbroken and labels intact.
- B. Immediately replace any broken, cracked or otherwise damaged tile with new material.

1.05 EXTRA MATERIALS

- A. At project completion furnish to the Owner not less than 6 square feet of each type and color of wall tile used in the project.

PART 2 PRODUCTS

2.01 PORCELAIN FLOOR TILE

- A. Nominal 24" x 24" porcelain stone as manufactured by Crossville, Dal-Tile or American Olean, or approved equal.

2.02 TERRAZZO TILE (POLISHED)

- A. Nominal 24" x 24" x 1/2" terrazzo tile as manufactured by Wausau - Tectura, or approved equal.

2.03 PORCELAIN TILE BASE

- A. Coved flat top base with inside & outside corner trim as required.

2.04 TERRAZZO TILE BASE (POLISHED)

- A. 4" X 12" nominal base with beveled top.

2.05 SETTING MORTAR

- A. Latex-Portland cement mortar conforming to ANSI A 118.4. The following manufacturers' systems are acceptable:
 - 1. DAP/DURABOND - D50 Plus Thin-Set Mortar with D-L16 Acrylic Latex Mortar Additive.
 - 2. HYDROMENT - Tile-Mate Thin Set 712 with Multi-Purpose Acrylic Latex #425.
 - 3. LATICRETE - Floor 'N Wall Thin-Set Mortar with 3701 Latex Grout and Mortar Admix.

2.06 GROUT

- A. Latex modified grout conforming to ANSI A118.6. The following manufacturers' systems are acceptable:

1. DAP/DURABOND - C-150 Wall Grout with D-L26 Acrylic Latex Grout Additive.
2. HYDROMENT - Ceramic Tile Grout with Multi-Purpose Acrylic Latex #425.
3. LATICRETE - Floor Grout and Joint Filler, 500 series with 1776 Grout Admix Plus.

2.07 TEMPORARY PROTECTIVE COATING

- A. Provide product recommended by tile manufacturer to protect exposed surfaces of tile against adherence of mortar and grout when compatible and necessary for proper installation with specific tile installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and areas where tile will be installed for compliance with requirements for installation and other conditions affecting performance of installed tile.
- B. Verify that substrates for setting tile are firm, dry, clean, and free from oil and waxy films and curing compounds.
- C. For tile exhibiting color variations within the ranges selected during sample submittals, verify that the tile has been blended in the factory and packaged so that tile units taken from one package show the same range of colors as those taken from other packages and match approved samples.

3.02 INSTALLATION

- A. For setting mortar conform to ANSI A 108.5 and procedures for thin-set tile set forth in the current Tile Council of America (TCA) Handbook for Ceramic Tile Installation.
- B. For grout conform to ANSI A 108.10 and procedures set forth in the current TCS Handbook for Ceramic Tile Installation.
- C. Where partial tiles are required cut tile to true, straight lines.
- D. Do not install broken, cracked, chipped, or irregularly formed or cut tile. All tile installation shall be square to the axes of the wall and of the building.
- E. Provide extruded aluminum end stops where porcelain floor tile transitions to carpet/V.C.T.

3.03 CLEANING

- A. After grout has set, clean the face of tile by procedures recommended in the TCA Handbook for Ceramic Tile Installation.

3.04 SEALING OF GROUT

- A. After grout has set and properly cured as recommended by the grout manufacturer, seal all floor tile grout with an approved sealer. Thoroughly cover the grout with sealer and remove any excess from the tile.

END OF SECTION

SECTION 09 51 00 ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Provide acoustical ceiling systems complete with all necessary components and accessories and install per manufacturer's directions.

1.03 QUALITY ASSURANCE

- A. Provide ceiling assemblies in manner to result in meeting or exceeding Noise Reduction Coefficients (NRC) and Ceiling Attenuation Class (CAC) ratings indicated and/or specified.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original packaging. Protect from damage during transporting and handling.
- B. Store materials in a dry enclosure, protected from exposure to the sun, adverse weather conditions, and damaging fumes.

PART 2 PRODUCTS

2.01 ACOUSTICAL PANEL CEILINGS

- A. Ceiling Type "C1" (Style 'A') – Mars Clima Plus, lay-in panels item No. 86785 Mineral fiberboard manufactured by USG Interiors, or approved equal with these standards:
 - 1. Nominal size: 24" x 24" x 3/4" with reveal edge.
 - 2. Flame spread: Class A (Flame spread 25 or less).
 - 3. Finish: White giving a light reflectance of .92.
 - 4. NRC Range: .65-.75
 - 5. CAC Range: 35-39
 - 6. Recycled Content: 74%
 - 7. Install in exposed grid with low gloss white finish.
- B. Ceiling Type "C2" (Style 'B') – Moisture resistant lay-in panels, Item No. 3260 embossed white vinyl finish, Firecode 'C' gypsum boards stipple white, manufactured by USG Interiors, Inc., or approved equal, with these minimum standards:
 - 1. Nominal Size: 24" x 24" x 1/2"
 - 2. Flame Spread: Class A (Flame Spread 25 or less).
 - 3. Finish: white stipple finish
 - 4. Install in exposed aluminum grid system with low gloss white finish.
- C. Suspension system shall be an exposed tee grid system, as manufactured by Donn Products, Inc., Westlake, Ohio, with exposed bottom flange. Tees shall form a 24" x 48" or 24" x 24" ceiling grid as required for specified lay-in units and be one of sufficient strength to carry imposed loads indicated on the Drawings and the fluorescent light fixtures. (Furnish grid with preformed inside and outside corners, bullnose where required.)
 - 1. Other acceptable manufacturers: Chicago Metallic

PART 3 EXECUTION

3.01 INSTALLATION

- A. Consult drawings for layout of grid system and follow same throughout.
- B. Suspend main tees from supporting members with galvanized wire not smaller than 12 gauge at each supporting member. Tie around supporting member and through holes in tees and give each wire end three twists around self. Level, space and align main runners at 4' o.c.
- C. Provide additional 12 gauge wire hangers to support light fixtures.
 - 1. At each corner of 2' x 4' or larger fixtures.
 - 2. At each corner of fixtures where corners do not occur at regularly spaced hanger wires.
 - 3. Spaced not over 4' along sides of fixtures longer than 4' (or continuous run fixtures) where side does not occur over main runners.
- D. Install cross-tees of proper length at right angles to main runners to create a grid. Where recessed light fixtures, diffusers or other openings require same, place a cross tee.

- E. Under ducts or other obstructions, adjust as necessary to provide secure suspension system, maintaining grid layout.
- F. Provide channel or angle shape perimeter wall molding at level for proper ceiling height.
- G. Provide angle molding at ceiling drops and carry acoustical panels up drop face where necessary.
- H. Lay-in acoustical panels. Provide hold-down clips for panels in spaces having doors to the exterior.
- I. Protect openings for ducts and/or recessed light fixture.

END OF SECTION

SECTION 09 65 00 RESILIENT FLOORING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Section includes vinyl composition tile and vinyl base.

1.03 SUBMITTALS

- A. Submit samples of materials for Architect's approval and color selection.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Vinyl Composition Tile:
 - 1. Contractor shall provide different colors of Vinyl Composition Tile to be utilized in a pattern or border design as shown on Drawings.
 - 2. Vinyl Composition Tile: 12" x 12" x 1/8" units, in the Style/Patterns as manufactured by the following manufacturers:
 - a. Tarkett.- Standard Commercial with Expressions Solid Tile and Accent Strips.
 - b. Armstrong World Industries.- Standard Excelon with Solid Color Excelon Feature Tile and Strips.
 - c. Azrock Industries, Inc.- Cortina with Solids Feature Tile and Strips.
 - 3. Colors shall be as selected by Architect.
- B. Vinyl Base: 4" high as shown on Drawings, coved, 1/8" thick "VPI Premium Wall Base" as manufactured by V.P.I., Johnsonite, Roppe, or approved equal. Color shall be as selected by Architect.
- C. Vinyl Composition Tile Reducer: 1/8" x 1-1/4" solid vinyl RRS-XX-C, as manufactured by Johnsonite, or approved equal. Color as selected by Architect.
- D. Carpet to Vinyl Composition Tile Adapter: Johnsonite CTA-XX-A, in color as selected by Architect.
- E. Stair Treads/Risers/Stair Base: Johnsonite Safe-T-Grip HT, or approved equal. Color as selected by Architect.
- F. Adhesives: As recommended by manufacturer of the flooring product for the specific installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Prepare and clean subfloor and apply materials with adhesives and accessories per manufacturer's directions.
- B. Lay tiles with same grain. Break colors under doors, unless otherwise indicated.
- C. Where tiles of varying thicknesses meet under doors, feather underlying floor surface with floorstone to bring surfaces flush and even.
- D. Where floor covering meets exposed concrete floor or tile of differing color, install 1-1/4" reducer strip under door.
- E. Install base after painting and floor covering are in place. Use maximum length to minimize joints with no sections less than 1'-0" in length. Cut for tight fit with no gaps at joints. Bend tight around outside corners (heat if required) and miter at inside corners.
- F. Where no base is scheduled, scribe floor coverings to wall, apply a thin bead of caulk (contrasting color) between floor tile and wall or door frame.

- G. Once the tile installation is complete, roll entire floor completely with an 80 lb roller to assure proper adhesion between tile and slab floor.

3.02 CLEANING AND BUFFING

- A. After all trades have completed work, thoroughly clean and machine buff resilient flooring.

3.03 MAINTENANCE MATERIALS

- A. At building completion, furnish Owner with not less than two (2) boxes additional (90 square feet) of neutral main color of V.C. tile used, not less than 6 additional square feet of each accent color of V.C. tile used, matching dye lot numbers, and not less than 8 additional lineal feet of each base used.

END OF SECTION

SECTION 09 68 00 CARPETING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Furnish and install carpeting where scheduled on the Drawings with all necessary trim and edging as required for a complete installation.

1.03 SUBMITTALS

- A. Submit samples of each type of carpet, showing all available colors and patterns, to the Architect for selection of colors and patterns.
- B. Submit product data on each type of carpet indicating compliance with specified properties.
- C. Manufacturer shall provide a maintenance manual for recommended care of the carpeting installed.
- D. Submit samples of edging in available colors to the Architect for color selection.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver carpet until the building is enclosed and HVAC system is operating.
- B. Deliver materials in manufacturer's original packaging and containers with the contents legibly marked on labeling.
- C. Store materials within the temperature range recommended by the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The following mills and products are approved as bidders on the project:
 - 1. J & J Industries, Inc., Evolve Modular, or approved equal.

2.02 MATERIAL

- A. Carpet shall meet the minimum specifications as follows:

<u>Carpet Specifications*</u>	<u>Evolve by J&J</u>
Surface Texture	Patterned Loop
Yarn	100% Nylon
Dye Method	"ColorLoc" Solution Dye
Pattern Repeat	N/A
Gauge	1/10
Secondary Backing	Nexus
Stain Protector	Pro-Tex
Size	24" x 24"
Flammability	Class 1
Smoke	Less than 450 flaming
Static Generation	Less than 3.0 kv (AATCC-134)
Warranties	Lifetime Wear
	Lifetime Static
	Lifetime Against Delamination
	Lifetime Against Tuft Bind Failure (edge ravel, yarn pulls, zippering)
	Lifetime Moisture Barrier

*Specifications are based on averages from normal manufacturing tolerances. Specifications may vary within normal industry tolerances of $\pm 5\%$.

- B. Walk off Tile:
Tiles shall be J & J / Invision RunWay Rib Carpet Tiles, or approved equal.
 - 1. Fiber type: 100% Encore Pile Yarn
 - 2. Size: 24" x 24" Square
 - 3. Backing: Nexus Modular
- C. Carpet and backing shall meet the following standards for burning characteristics when tested according to the ASTM E 84 Tunnel Test:
 - 1. Flame Spread - 75 or less
 - 2. Smoke Density - 450 or less
- D. Colors and Patterns:
 - 1. Color shall be selected by Architect.
 - 2. Colors and patterns made available for the carpets meeting specifications will be one of the factors determining approval by the Architect.
- E. Adhesive: Type for indoor installation as recommended by the carpet manufacturer.
- F. Edging: Solid vinyl, Johnsonite EG-XX-L, or as approved by the carpet manufacturer. Color shall be as selected by the Architect.

PART 3 EXECUTION

3.01 PREPARATION

- A. Broom clean floors prior to installation of carpeting.
- B. Vacuum clean and wet mop floor surfaces prior to installation of carpeting.

3.02 CLEANING AND PROTECTION

- A. Carpet shall be cleaned thoroughly after installation.
- B. Protect carpet from soiling until Owner is ready to move into the building.

END OF SECTION

SECTION 09 90 00 PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Paint and finish schedules indicate the minimum coatings that can be anticipated to produce the desired results. Before submitting bid, Contractor and material suppliers examine such schedules and these specifications and should number or type of coatings be insufficient or inappropriate to achieve proper results notify Architect and receive his instructions; otherwise, should coatings specified not produce the desired coverage or finish results, Architect may require additional or other type coating and such shall not constitute a basis of claim for "Extra Work".
- B. Notwithstanding any omissions or discrepancies in paint and finish schedules, every item logically requiring paint or finish shall be properly painted or finished. Consult Architect for proper finish if not specified.

1.03 SUBMITTALS

- A. Contractor shall submit full range of color chips for Architect's color selection. It is anticipated that a limited palette of colors will be selected, however, no color or variety of colors selected will constitute claim for extra charge by Contractor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish first-quality paints as manufactured by Sherwin-Williams, Pittsburgh, Glidden, Pratt and Lambert or Benjamin-Moore.

2.02 MATERIAL

- A. Except as noted, schedules herein indicate selections of materials from Sherwin-Williams to be used as a guide for establishing type of quality and finish desired.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces of rust, grease, oils, and other foreign matter that would adversely affect finished appearance or protective properties of the paint.
- B. Fill holes and cracks in surfaces with spackle. Apply no paint until spackle is thoroughly dry.
- C. Touch up knots and sappy spots on wood materials to be painted with pure shellac before priming.
- D. Sand and otherwise clean and smooth wood surfaces to be finished. Do not use steel wool on surfaces scheduled to receive water-based finishes.
- E. Before painting or finishing adjacent areas, remove and protect hardware, accessories, plates, light fixtures and similar items. On completion of area, replace such items.

3.02 APPLICATION

- A. Spread materials evenly and smoothly, without runs or sags. Apply interior latex paints with roller and/or brush. Spray apply paints to metal doors and metal frames.
- B. Prime exterior surface materials immediately after their installation, or whenever possible, before installation.
- C. Color undercoats to approximate value of finish coat.
- D. Sand woodwork and metal trim between coats with fine sand paper to produce an even, smooth finish.
- E. Cover surfaces to be stained with uniform stain coat; wipe off as required.

- F. Apply materials per manufacturer's directions and obtain good coverage and perfect finish for type of paint or finish.
- G. "Touch up" paint and finish surfaces after all trades and contractors have completed their work.
- H. After wood doors are fitted, remove and give top and bottom edges one coat of pure shellac for interior doors, and one coat of same followed by one coat of spar varnish for exterior doors. Do not allow edge coating to lap onto face surfaces where natural finishes are required.

3.03 PAINTING SCHEDULE (EXTERIOR)

- A. Ferrous Metal - Steel Doors and Frames, Bollards, Structural Steel, Plates (alkyd):
 - 1. One (1) coat Steeltech Shopcoat Metal Primer, S4501 Pratt & Lambert, DFT-3.0 mils.
 - 2. Two (2) coats Techgard Enamel, DFT-2.0 mils/coat (gloss).
- B. Concrete Masonry Units (100% Acrylic)(Semi-Gloss):
 - 1. One (1) coat Heavy Duty Block filler at 10.0-18.0 mils DFT.
 - 2. Two (2) coats MetaLux Semi-Gloss Coating at 1.5-4.0SFT/ct.

3.04 PAINTING SCHEDULE (INTERIOR)

- A. Gypsum Wall Board (acrylic latex) (semi-gloss):
 - 1. One (1) coat Pro-Line Premium Interior Latex Wall Primer
 - 2. Two (2) coats Martin Senour T.P.S. Interior Multi-Surface Alkyd Stain Blocker Latex Enamel.
- B. Metal Doors/Frames and Miscellaneous Metals (alkyd)(semi-gloss):
 - 1. One (1) coat Kem Bond HS Universal Primer, DFT-2.0 mils.
 - 2. Two (2) coats ProClassic Interior Alkyd Semi-Gloss Enamel, DFT-1.7 mils/coat.
- C. All wood trim (polyurethane):
 - 1. One (1) coat Natural Paste Wood Filler (tinted)
 - 2. One (1) coat PPG Olympic Premium Interior Fast Dry Wood Stain Oil Based 41570 Series (match pre finished wood doors)
 - 3. Two (2) coats PPG Olympic Premium Interior Oil Based Polyurethane Clear 43884, 43886, 1.0 mils/coat.

END OF SECTION

SECTION 10 16 00 METAL TOILET COMPARTMENTS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Furnish and install metal toilet compartments and screens as shown on Drawings.

1.03 SUBMITTALS

- A. Shop drawings: Submit shop drawings for fabrication and erection of toilet partition assemblies and instructions for installation of anchoring devices built into other work.
- B. Samples: Submit full range of color samples.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials during transit, storage, and construction against soiling, staining, and damage. Panels, doors, and pilasters shall arrive at job site with special protective covering.
- B. Handle material to prevent chipping, scratches, breakage, soiling, or other damage.
- C. Inspect materials upon delivery. Notify Architect of broken or damaged materials. Procure replacements immediately, so as not to disrupt schedule.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide floor mounted overhead braced products of one of the following:
 - 1. Global Steel Products Corp.
 - 2. Knickerbocker Partition Corp.
 - 3. Sanymetal Products Co.
 - 4. Weis/Robart Partitions

2.02 MATERIALS

- A. Steel Sheets: ASTM A 591, Class C, galvanized-bonderized, of following minimum thickness:
 - 1. Pilasters: 18 gauge.
 - 2. Panels and Screens: 20 gauge.
 - 3. Doors: 22 gauge.
 - 4. Concealed Anchorage Reinforcement: 12 gauge.
 - 5. Concealed Tapping Reinforcement: 14 gauge.
- B. Core Materials for Metal Partitions: Manufacturer's standard sound-deadening honeycomb of impregnated kraft paper, in thickness to provide finished dimension of 1" minimum for doors and panels, 1¼" minimum for pilasters.
- C. Stirrup Brackets: Manufacturer's standard, non-ferrous alloy with satin chrome finish.
- D. Hardware and Accessories (per compartment): Manufacturer's standard, heavy-duty operating hardware and accessories, non-ferrous alloy with satin chrome finish. Handicap accessible compartments shall have door hardware that is operable by the physically impaired.
- E. Anchorages and Fasteners: Manufacturer's standard theft-proof exposed fasteners, finished to match hardware.

2.03 FABRICATION

- A. Pressure laminate face sheets to core with edges sealed with continuous locking strip or lapped and formed edges. Miter and weld corners with weld ground smooth.
- B. Furnish unit with cut-outs, drilled holes, and internal reinforcement to receive partition mounted hardware, accessories, and grab bars, as indicated.
- C. Hardware: Furnish for each door as follows:
 - 1. Hinges: Cutout inset type, adjustable to hold door open at any angle up to 90°.
 - 2. Latch and Keeper: Recessed latch units with combination rubber faced door strike and keeper.
 - 3. Coat Hook: Manufacturer's standard unit, combination hook and rubber-tipped bumper.
 - 4. Door Pull: Manufacturer's standard.

- D. Urinal Screen: Wall hung, bracket, and pilaster support with overhead braced, 18" x 42", same basic construction and finish as toilet partitions.

2.04 FINISH

- A. Apply two coats of thermosetting enamel finish, applied by electrostatic process, and baked in accordance with paint manufacturer's instructions.
- B. Colors: Two of manufacturer's standard colors as selected by Architect.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install compartments and urinal screens rigid, straight, plumb, and level with the panels laid out as shown. Secure panels to walls and pilasters with not less than two brackets. Maximum clearances shall be as follows:
 - 1. 1/2" between panel and pilasters
 - 2. 1/4" between door edge and pilasters
 - 3. 1" between panels and walls
- B. Keep components clean during installation. Remove adhesives, sealants, and other stains. Replace permanently stained or damaged components.
- C. Hardware and Adjustments: Adjust and lubricate hardware for proper operation after installation.
 - 1. Set hinges on in-swing doors to hold doors open approximately 15 degrees from the closed position when unlatched.
 - 2. Set hinges on out-swing doors to return to fully closed position.

3.02 PROTECTION, CLEANING, AND FINAL ADJUSTMENT

- A. Protect units after erection so that there will be no indication of use or damage at the time of acceptance. Repair defective or damaged work or replace work that cannot be repaired to Architect's satisfaction.
- B. Perform final adjustments to door hardware and other operating parts of the assembly just prior to final inspection.
- C. Clean exposed surfaces of compartments, screens, hardware and fittings, and accessories.

END OF SECTION

SECTION 10 22 26.13 ACCORDION PARTITIONS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 RELATED DOCUMENTS

- A. All applicable provisions of the Bidding and Contract Requirements, and Division 1 - General Requirements shall govern the work under this section.

1.03 SUMMARY

- A. Provide all labor, materials, necessary equipment and services to complete the accordion partitions, as indicated on the Drawings, and as specified herein or both.

1.04 QUALITY ASSURANCE

- A. The accordion partitions herein specified shall be furnished and installed by a local distributor authorized by the operable wall manufacturer. Local distribution is required to insure prompt project coordination and future customer service.

1.05 ACOUSTICAL PERFORMANCE

- A. Laboratory acoustical performance of the operable wall shall have been tested in an independent acoustical laboratory in accordance with ASTM E90 test procedure, and shall have attained an STC rating of no less than 35. A written test report by the test facility shall be available upon request. NSSEA "Class" ratings are not acceptable.

1.06 SUBMITTALS

- A. Shop Drawings: Submit shop drawing fully describing partition fabrication, layout, and installation. Include details of track, trolleys, hardware, etc. Indicate loading to be imposed in the supporting structure. Show all anchorage, accessory items, caulking, and finishes.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Modernfold, Inc, Panelfold, Hufcor, or approved equal.
- B. Product: Modernfold , Soundmaster Model SM80 Accordion Folding Partitions.

2.02 OPERATION

- A. Operation shall be manual, top supported.

2.03 FRAME CONSTRUCTION

- A. Frame construction shall consist of steel hinge plates welded to .187" (5) diameter vertical steel rods. Single row at bottom, intermediate rows approximately 42" (1067) on center, single row at top (over 10'-0" (3048) high, double-truss row at top.)
- B. Trolley pin of high tensile alloy steel to be encased in structural hinge plate channel.

2.04 FINISH

- A. Outer covering shall be Modernfold heavy duty vinyl with woven fiber backing.
- B. Outer covering shall be Class "A" flame spread rated.

2.05 SUSPENSION SYSTEM

- A. Suspension System shall consist of continuous C channel shape track, connected to the structural support.
- B. Frame shall be supported by ball bearing trolley assemblies.

2.06 SOUND SEALS

- A. Sound seals shall be pairs of flexible sweep strips at top and bottom. Vertical female sound channel – polyurethane foam lined.

2.07 AIR RELEASE SYSTEM

- A. Air trapped within the partition shall be released during entire stacking operation through .375" (10) diameter holes, which comprise a minimum 5% lead post face area.

2.08 SOUND INSULATION

- A. Minimum 26 ga. V-grooved steel panels and heavy duty flame resistant acoustical membrane.
- B. Each panel attaches to frame with steel leaf fasteners.

2.09 GRIP TYPE HAND PULLS

- A. Hand pulls shall be die cast zinc, satin chrome finish, and include a thumb release latch mechanism.
- B. Extruded aluminum or plastic hand pulls will not be accepted.

PART 3 INSTALLATION, EXECUTION AND WORKMANSHIP

3.01 PREPARATION

- A. Preparation of opening shall be by general contractor. Any deviation or site conditions contrary to approved shop drawings shall be called to the attention of the architect.
- B. Delivery to the job site shall be coordinated by general contractor. Proper storage of doors before installation and continued protection during and after installation shall be the responsibility of the general contractor.

3.02 INSTALLATION

- A. Installation shall be by a local Modernfold authorized factory trained installer. Installation shall be in accordance with approved shop drawings and in accordance with ASTM E557.
- B. Installation shall be guaranteed for one (1) year against defects in material and workmanship.

END OF SECTION

SECTION 10 28 00 TOILET ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Provide toilet accessories as shown on the Drawings and included herein in the Specifications and schedules.
- B. Provide grab bars and handicap assist devices specified herein, shown on shop drawings, and as required to comply with the Americans with Disabilities Act (ADA) Guidelines.
- C. Items not scheduled are to be furnished by the Owner and installed by the Owner.

1.03 SUBMITTALS

- A. Submit manufacturer's technical data and installation instructions for each accessory.

1.04 QUALITY ASSURANCE

- A. Coordinate accessory locations with other work to avoid interference and ensure proper operation and servicing of accessory unit. Advise the Architect of any conflicts prior to installation.
- B. Coordinate with toilet partition manufacturers, millwork companies, and building trades for proper installation and fastening devices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Toilet accessories scheduled are items manufactured by Bobrick Wash Room Equipment. Comparable products manufactured by Bradley Corporation or American Specialties, Inc., are also acceptable.

2.02 MATERIALS

- A. Stainless steel shall be 302/304 type. Steel shall be cold rolled, commercial quality, 20 gauge minimum. Chromium plated metal shall be nickel and chromium electro-deposited on base metal, ASTM B 456, Type SE2.
- B. All fasteners, screws, bolts, and other devices shall be same material as accessory unit or galvanized steel where concealed.
- C. Where locks are required for any particular type of toilet accessory, the same keying shall be used throughout the project. Furnish two keys for each lock.

2.03 MIRRORS

- A. Mirrors shall consist of mirror glass, 1/4" thick, type 1, class 1, quality 2, conforming to FS-DDG451 with silvering, copper coating and protective organic coating complying with FS-DM411.
- B. Mirrors shall have stainless steel framing, Type 302/304 with polished #4 finish and galvanized steel sheet backing with galvanized steel sheet mounting devices.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install toilet accessories in accordance with manufacturer's instructions using fasteners which are appropriate to substrate and recommended by manufacturer of unit.
- B. Install unit plumb and level, firmly anchored in locations indicated to support the loading required by ADA Guidelines.
- C. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly.
- D. Clean and polish all exposed surfaces after removing protective coatings.

- E. Secure mirrors to wall and conceal fastening in a tamper proof manner with special hangers, toggle bolts, and screws. Set units plumb, level, and square at locations indicated in accordance with manufacturer's instructions for type of substrate. Clean all exposed surfaces of mirror units in compliance with manufacturer's recommendations.

3.02 SCHEDULE

- A. Two (2) required: Bobrick, B-290, Framed 24" x 36" Mirror, or approved equal.
- B. Two (2) required: Bobrick, B-3944, Recessed Paper Towel Dispenser and Waste Receptacle, or approved equal.
- C. Four (4) required: Bobrick, B-27460, Toilet Tissue Dispenser, or approved equal.
- D. Two (2) required: Bobrick, B-5507.99 x 36" Grab Bar, or approved equal.
- E. Two (2) required: Bobrick, B-5507.99 x 42" Grab Bar, or approved equal.
- F. Four (4) required: Bobrick, B-682 Coat & Hat Hook, or approved equal.
- G. Two (2) required: Bobrick B-292-Frame 24" x 60" Mirror, or approved equal.

END OF SECTION

SECTION 10 40 00 IDENTIFYING DEVICES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Furnish and install room signs, and plaque as specified herein.

1.03 SUBMITTALS

- A. Submit list of signs having lettering only.
- B. Submit graphic layout of signs having a combination of lettering, braille, and graphic symbols.
- C. Submit chart of available colors for selection of colors.
- D. Submit a full size rubbing of plaque. Obtain approval of rubbing before casting. Resubmit rubbing with corrections as required.

PART 2 PRODUCTS

2.01 ROOM SIGNS

- A. Manufacturers:
 - 1. Best Manufacturing Company
 - 2. Mohawk Sign Systems
 - 3. or Approved Equal
- B. Material:
 - 1. 1/8" thick laminate of melamine plastic surface and phenolic core.
 - 2. Color: As selected by the Architect.
 - 3. Process: Engraving process to raise graphics approximately 1/32 inch above surface in accordance with ADA requirements, similar to Best's "Graphic Blast" process.
 - a. Letter Style: Raised 1½ inch Helvetica Medium - C.
- C. Size:
 - 1. Room Signs shall be 2½ inch width by length required with ¼ inch border.
 - 2. Rest Room Signs shall be approximately 6 x 8 inches with international symbols for accessibility and for each sex, as well as lettered identification and braille identification of sex.
- D. Quantity:
 - 1. Room Signs: Twenty (20), Text to be determined later.
 - 2. Rest Room Signs: One (1) each.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install room signs where designated on Drawings or by Architect's instructions.
- B. Mount room signs with adhesive furnished and recommended by manufacturer.
- C. Install plaque utilizing the concealed mounting method in strict accordance with manufacturer's requirements.

END OF SECTION

SECTION 10 44 00 FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.
- B. National Fire Protection Association (NFPA): NFPA 10 - Standard for Portable Fire Extinguishers.

1.02 SUMMARY

- A. Furnish and install fire extinguisher cabinets at the locations indicated on the Drawings.
- B. Furnish and install fire extinguishers fully charged and ready for service.

1.03 SUBMITTALS

- A. Submit manufacturer's data including size, capacity, required recess for cabinets, details of trim, and photos or drawings of items.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. For purpose of establishing standards of design, functions, and quality or materials, the following specifications are taken from the current published manual of J. L. Industries, Bloomington, Minnesota. Other manufacturers' products conforming to these standards are acceptable.

2.02 CABINETS

- A. Fire extinguisher cabinets shall be equivalent to J. L. Industries Model No. Academy 1027-F-12 semi-recessed cabinet for wall thicknesses as shown on Drawings. Door and trim shall be extruded aluminum with satin anodized finish. Door to be full glass with 1/4" clear acrylic glazing. Cabinet shall be 18 gauge steel box. Mount bottom 40" above floor unless noted otherwise.
- B. Fire extinguishers shall be equivalent to J. L. Industries Cosmic Model 10E, with U. L. Rating 4A-60BC. Provide hook for fire extinguishers without cabinets. See Floor Plans for locations

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install fire protection items in accordance with manufacturer's instructions.

END OF SECTION

SECTION 10 73 16 ALUMINUM CANOPIES/SUNSHADES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Furnish and install aluminum, rod-suspended canopies at building walls as shown on the Drawings and as specified herein.

1.03 SUBMITTALS

- A. Submit shop drawings for fabrication of canopies, showing sections of all components, hanger rod spacing, and dimensions.
- B. Submit instructions for installation of anchorage built into other work and for erection.
- C. Submit samples of manufacturer's colors for color selection.
- D. Submit a twenty (20) year paint finish warranty from manufacturer stating that fluorocarbon finish will be:
 - 1. Free of fading or color change in excess of 5 NBS units as measured per ASTM D 2244.
 - 2. Free of chalking in excess of numerical rating of 7 when measured in accordance with standard procedures of ASTM D 659.
 - 3. Not subject to peeling, cracking, chipping or delamination.

1.04 QUALITY ASSURANCE

- A. Fabrication of aluminum canopies shall be by a manufacturer who has adequate plant, equipment and skilled tradesmen to perform the work expeditiously and accurately.
- B. The manufacturer shall have executed projects of a similar scope and nature for a minimum of five (5) years.
- C. Manufacturer shall have adequate facilities to ensure rigid quality control of incoming materials and manufacturing processes.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Items shall be packaged or crated to prevent damage in shipment and handling. Finish surfaces shall be protected by sturdy wrappings.
- B. Store items in original packaging until just prior to installation.
- C. Handle items as recommended by the manufacturer in order to prevent damage.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Mapes Industries, Inc., Lincoln, Nebraska (800) 228-2391, or approved equal. Proposed substitutions shall be submitted not less than seven (7) days prior to the date bids are due, in accordance with the Instructions to Bidders.

2.02 FABRICATION

- A. Canopies shall be fabricated and shipped as units, ready for erection. Units shall be "Super Lumideck Hanger Rod" type. Units shall be fabricated of extruded aluminum components and designed to withstand 30 psf roof live load and pressures due to a 90 mph wind. Space hanger rods as indicated on the Drawings.

2.03 PHYSICAL CHARACTERISTICS

- A. Projection from Wall: 4'-0".
- B. Canopies Soffit: Flat
- C. Sunshades: .110" Louver
- D. Fascia: Minimum 8" height
- E. Drainage: Edge gutter with scupper opening.
- F. Suspension: Round rods with square escutcheon plates (both exterior and interior).
- G. Finish: Fluorocarbon coating with twenty (20) year warranty. Color shall be as selected by the Architect.

2.04 FIELD SEALANT

- A. Color coordinated primerless silicone as recommended by the canopy manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrate to insure it is properly secured and prepared to receive canopy units.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's instructions for erection, and installation. Install in accordance with approved shop drawings.
- B. Anchor canopies securely in place using fasteners spaced in accordance with manufacturer's recommendations for design wind load criteria.
- C. Dissimilar Metals:
 - 1. Where metal components might be in contact with dissimilar metals, execute juncture to facilitate drainage and minimize possibility of galvanic action.
 - 2. At the potential point of contact with dissimilar metal use a tape which can be placed between the metals.
- D. Field apply sealant to penetrations, transitions, and other locations necessary for airtight, waterproof installation.

END OF SECTION

SECTION 210517 SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

- A. Sleeves.
- B. Sleeve-seal fittings.
- C. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.2 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete/masonry walls.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. 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 (50 mm) above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping.

3.2 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system or Sleeve-seal fittings>.
 - 2. Concrete Slabs and Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves or Sleeve-seal fittings>.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.
 - 3. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.

END OF SECTION 210517

SECTION 210518 ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 210518

SECTION 21553 IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032 inch (0.8 mm), thick, with predrilled holes for attachment hardware.
 - 2. Letter Color: Red.
 - 3. Background Color: White.
 - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 6. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
 - 2. Letter Color: Red.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
- B. Letter Color: Red.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - G. Fasteners: Stainless-steel rivets or self-tapping screws.
 - H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
 - I. Label Content: Include caution and warning information, plus emergency notification instructions.
- 2.3 PIPE LABELS
- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
 - B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
 - C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.
 - D. Pipe-Label Colors:
 - 1. Background Color: White.
 - 2. Letter Color: Red.
- 2.04 VALVE TAGS
- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or S-hook.
 - 3. Valve-Tag Color: White.
 - 4. Letter Color: Red.
 - B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.
- 2.05 WARNING TAGS
- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

- 3.01 PREPARATION
- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- 3.02 LABEL INSTALLATION
- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
 - B. Coordinate installation of identifying devices with locations of access panels and doors.
 - C. Install or permanently fasten labels on each major item of mechanical equipment.
 - D. Locate equipment labels where accessible and visible.
 - E. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.

2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- 3.03 VALVE-TAG INSTALLATION
- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.
 - B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
 1. Valve-Tag Size and Shape:
 - a. Wet-Pipe Sprinkler System: 1-1/2 inches (38 mm), round.
- 3.04 WARNING-TAG INSTALLATION
- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 210553

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SECTION 211313 SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinklers.

1.2 SYSTEM DESCRIPTIONS

- A. Furnish all labor, services, materials and equipment and perform all work including system design as necessary and required to construct Fire Protection Work complete for the renovated and expanded Building "C" areas and as follows:
 - 1. Fire protection system shall employing automatic sprinklers. The system shall be connected to the water supply so that water discharges immediately from sprinklers opened by fire. All sprinkler system flow-and tamper switches shall alarm to the building fire alarm system upon detection of flow.

1.3 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. The sprinkler system shall be sized per hydraulic calculations to meet the minimum standards indicated. The fire protection system design shall be signed and sealed by a professional engineer. Provide additional protection, if required, per codes and standards.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

1.4 SUBMITTALS

- A. Product Data: For each type of product provided.
- B. Shop Drawings: For complete sprinkler system and accessories, include plans, elevations, sections, details, and attachments sealed by a professional engineer to include:
 - 1. Hydraulic calculations with professional engineer's seal.
- C. Qualification Data: For qualified Installer.
- D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
- E. Welding certificates.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For complete sprinkler system to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.6 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method
- B. Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
 - 3. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa).
- B. Ball Valves:
 - 1. Standard: UL 1091 except with ball instead of disc.
 - 2. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
 - 3. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 4. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
- C. Check Valves:
 - 1. Standard: UL 312.
 - 2. Pressure Rating: 250 psig (1725 kPa) minimum.
 - 3. Type: Swing check.
 - 4. Body Material: Cast iron.
 - 5. End Connections: Flanged or grooved.
- D. Bronze OS&Y Gate Valves:
 - 1. Standard: UL 262.
 - 2. Pressure Rating: 175 psig (1200 kPa).
 - 3. Body Material: Bronze.
 - 4. End Connections: Threaded.
- E. Iron OS&Y Gate Valves:
 - 1. Standard: UL 262.
 - 2. Pressure Rating: [250 psig (1725 kPa) minimum] [300 psig (2070 kPa)].
 - 3. Body Material: Cast or ductile iron.
 - 4. End Connections: Flanged or grooved.
- F. NRS Gate Valves:
 - 1. Standard: UL 262.
 - 2. Pressure Rating: 250 psig (1725 kPa) minimum.
 - 3. Body Material: Cast iron with indicator post flange.
 - 4. Stem: Nonrising.
 - 5. End Connections: Flanged or grooved.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig (1200 kPa) minimum

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
 - b. High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Dry-Pipe Valves:

1. Standard: UL 260.
2. Design: Differential-pressure type.
3. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
4. Air-Pressure Maintenance Device:
5. Standard: UL 260.
6. Type: Automatic device to maintain minimum air pressure in piping.
7. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) outlet pressure.
8. Air Compressor:
 - a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - b. Motor Horsepower: Fractional.
 - c. Power: 120-V ac, 60 Hz, single phase.

C. Deluge Valves:

1. Standard: UL 260.
2. Design: Hydraulically operated, differential-pressure type.
3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
4. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
5. Air-Pressure Maintenance Device:
 - a. Standard: UL 260.
 - b. Type: Automatic device to maintain minimum air pressure in piping.
 - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) outlet pressure.
6. Air Compressor:
7. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
8. Motor Horsepower: Fractional.
9. Power: 120-V ac, 60 Hz, single phase.
10. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application

- D. Automatic (Ball Drip) Drain Valves:
 - 1. Standard: UL 1726.
 - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
 - 3. Type: Automatic draining, ball check.
 - 4. Size: NPS 3/4 (DN 20).
 - 5. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Branch Outlet Fittings:
 - 1. Standard: UL 213.
 - 2. Pressure Rating: 175 psig (1200 kPa) minimum.
 - 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 4. Type: Mechanical-T and -cross fittings.
 - 5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 7. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Adjustable Drop Nipples:
 - 1. Standard: UL 1474.
 - 2. Pressure Rating: 250 psig (1725 kPa) minimum.
 - 3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 4. Size: Same as connected piping.
 - 5. Length: Adjustable.
 - 6. Inlet and Outlet: Threaded.
- C. Flexible, Sprinkler Hose Fittings:
 - 1. Standard: UL 1474.
 - 2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 3. Pressure Rating: 175 psig (1200 kPa) minimum.
 - 4. Size: Same as connected piping, for sprinkler

2.8 SPRINKLERS

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
 - 3. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
- B. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Early-Suppression, Fast-Response Applications: UL 1767.
 - 2. Nonresidential Applications: UL 199.
 - 3. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- C. Sprinkler Finishes:
 - 1. Chrome plated.
 - 2. Bronze.
 - 3. Painted.
- D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- E. Sprinkler Guards:
 - 1. Standard: UL 199.
 - 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 PRESSURE GAGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.
- D. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform hydraulic calculations for complete system design according to NFPA standards.
- B. System design drawings shall be sealed by a professional engineer.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- F. Install sprinkler piping with drains for complete system drainage.
- G. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- H. Fill wet pipe sprinkler system piping with water.
- I. Install pipe insulation on sprinkler piping in areas subject to freezing.
- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.5 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Coordinate with fire-alarm tests. Operate as required.
 - 5. Verify that equipment hose threads are same as local fire-department equipment.
 - C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.7 CLEANING
- A. Clean dirt and debris from sprinklers.
 - B. Remove and replace sprinklers with paint other than factory finish.
- 3.8 PIPING SCHEDULE
- A. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints for wet pipe systems.
 - 2. Standard-weight, galvanized steel pipe with with threaded ends; uncoated, threaded-end fittings and threaded joints for dry-type systems.
 - B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints
- 3.9 SPRINKLER SCHEDULE
- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers with cover plates to match ceiling color.
 - 3. Wall Mounting: Sidewall sprinklers.
 - B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

SECTION 220100 GENERAL PROVISIONS

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 the work in Division 22 – Plumbing Work.
- B. This Section is hereby made a part of all other sections of Division 22 – Plumbing Work, as if repeated in each.

1.2 DESCRIPTION OF WORK

- A. Provide items, articles, materials, operation and methods required by drawings and specifications including labor, equipment, supplies and incidentals necessary for completion of work in Division 22 - Plumbing Section.
 - 1. Record documents.
 - 2. Coordination drawings.

1.3 QUALITY ASSURANCE

- A. All permits, licenses and utility fees that are required by governing authorities for the performance of the work shall be procured and paid for by the Contractor.
- B. All work shall be performed in compliance with all applicable and governing safety regulations including the regulations of the Occupational and Safety Health Act. All safety lights, signs and guards required for performance of work shall be provided by the Contractor.
- C. All work shall conform to the requirements of all applicable codes, ordinances and regulations including the rules and regulations of the National Electrical Code, the National Fire Protection Association, the 2012 International Building Code, 2012 International Mechanical and Plumbing Codes, O.S.H.A. and all State and local laws, codes and ordinances.
- D. Laws, codes, ordinances and regulations shall take precedent excepting only where the work called for by the drawings and specifications exceeds by quality and quantity.
- E. Fixtures, appliances, equipment and materials, which are subject to Underwriter's Laboratory tests, shall bear such approval.
- F. Manufacturer's listed in the equipment schedules are intended to establish quality only and does not limit equal products by other manufacturers. Mechanical and electrical designs are based on the requirements for the specified manufacturers listed on the equipment schedules. Conduit, disconnects, motor starters, breakers, fuses and wire sizes are selected on basis of scheduled equipment. Increased current requirements necessitating larger wire, breakers, switches, etcetera, to accommodate any alternate or substitute manufacturer's equipment, other than as shown on drawings shall be provided without any increase in contract price by Contractor furnishing the equipment.
- G. Manufacturers, where specifically called for, must provide factory tests, unit installation observations, unit start-up and tests, etcetera, as specified, and submit signed reports to the Construction Inspector upon completion of these services. Subletting of these services will not be permitted. Shop drawing submittals shall be accompanied with a letter of certification by the manufacturer that the specified services shall be provided. Failure to do so shall be cause to reject the shop drawing submittals.
- H. The contract drawings are in part schematic and intended to convey the scope of work and indicate the general layout, design and arrangement. The Contractor shall follow these drawings in the layout of his work and shall consult general construction drawings, mechanical and electrical drawings and all other drawings for this project, and shall verify all existing site conditions to determine all conditions affecting the work shown or specified. The contract drawings are not to be scaled and the Contractor shall verify spaces in which the work is to be installed.
- I. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, Architect shall be notified before proceeding with installation.
- J. Work in cooperation with one another to fit piping into the structure as job conditions may demand. All final decisions as to right of way and run of pipe to be made by Construction Inspector or his representative.
- K. All work shall be performed by trained mechanics of a particular trade involved and done in a neat and workmanlike manner as approved by the Architect.
 - 1. Work shall be performed in cooperation with other trades and scheduled to allow timely and efficient completion of project.

2. Furnish other trades advance information on locations and sizes of frames, boxes, sleeves and openings needed for work, and also furnish information and shop drawings necessary to permit other trades affected to install their work properly without delay.
3. Where there is evidence that work of one trade will interfere with work of other trades, all trades shall assist in working out space conditions to make satisfactory adjustments.
- L. Work installed before coordinating with other trades causing interference with work of such other trades shall be changed to correct such condition without increase in contract price and as directed by the Architect.
- M. Where specific details and dimensions are not shown on the drawings, the Contractor shall take measurements and make layouts for the proper installation of the work and coordination with all other work on the project. In case of any discrepancies between the drawings and the specifications, it shall be assumed, by the signing of the Contract, that the higher cost (if any difference in costs) is included in the contract price, and the Contractor shall perform the work in accordance with the drawings or with the specifications, as determined and approved by the Project Architect.
- N. Definitions:
 1. "Piping" includes, in addition to pipe, all fittings, valves, sleeves, hangers, and other supports and accessories related to such piping.
 2. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, or in crawl spaces.
 3. "Exposed" means not installed underground or "concealed" as defined above.
 4. The words "furnish and install", "provide", "furnish", "install", or equivalent words are used or are understood, to mean the Contractor shall furnish and completely install the system, service, equipment, or material named, together with other associated devices, equipment, material, wiring, piping, etcetera as required for a complete operating installation, and conforming to the manufacturer's standards and recommendations.
 5. It is the intent of the Plumbing specifications and drawings to call for finished work, tested and ready for operation.
 - a. All apparatus, appliances, materials or work not shown on drawings, but mentioned in specifications, or vice versa, and/or all incidental accessories necessary to make work complete and ready for operation, even though not specified or shown on drawings, shall be furnished and installed without increase in contract price.
 - b. Should there be discrepancies or questions of intent, refer matter to Construction Inspector in writing for decision before ordering any equipment or materials, or before starting any related work.

1.4 RECORD DOCUMENTS

- A. Within 90 days after the date of system acceptance, provide record drawings and indicate installed conditions for the following:
 1. Piping systems, size and location, for both exterior and interior with terminal water design flow rates.
 2. Locations of control devices and valve final setpoint positions.
 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed with performance data.

1.5 COORDINATION

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 1. Indicate the proposed locations of piping, equipment, and materials. Include the following:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Exterior wall and foundation penetrations.
 - c. Fire-rated wall and floor penetrations.
 - d. Equipment connections and support details.
 - e. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- B. 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

- A. All materials and equipment shall be new and shall bear manufacturer's name, model number, serial number, date of manufacture and other identification marking.
- B. All materials and equipment shall be standard product of manufacturer regularly engaged in production of required type of material or equipment for at least 5 years (unless specifically exempted by the Construction Inspector) and shall be manufacturer's latest design having published properties.

2.2 ELECTRICAL EQUIPMENT

- A. General: Unless specified or shown otherwise, the Contractor shall furnish required motors for equipment furnished in the Plumbing Work. Motors shall be provided where indicated and as required for operation of the equipment being furnished. Motors shall be designed for full voltage starting unless otherwise specified or noted on drawings and shall be suitable for continuous duty at 40°C. ambient and at altitude of 3300 feet (1000 m) above sea level. All motors shall be selected, designed and fabricated in conformance with the requirements of NEMA MG 1 standard.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

- A. The responsibility for any cutting of construction, which is required for the installation work, shall be by the Contractor. The Contractor shall coordinate with the Architect before any cutting and obtain approval prior to any cutting.
 1. Where openings for plumbing work are provided under other sections of the specifications, this Contractor shall be responsible for locating and providing the proper dimensions for all such openings.
- B. Cutting shall be done with extreme care and in such a manner that the strength of the structure will not be endangered. Wherever possible, openings in concrete or masonry construction shall be by concrete saw or rotary core drill. Openings in any construction shall be cut the minimum size required for the installation of the work.
 1. Adequate protection shall be provided to prevent damage to adjacent areas and to prevent dust from spreading to adjacent areas.
 2. The use of jack hammers will not be permitted.
- C. Where openings or holes are cut in existing construction and the cutting breaks existing electrical circuitry or control circuitry, or communications, conduit and wiring, then it shall be the responsibility of the Contractor to have the circuitry, conduit and rewiring re-routed and to complete the circuitry as required and as approved by the Owner. Temporary completion shall be provided where necessary before the permanent re-routing and completion work is finished. All costs for this work shall be the responsibility of the Contractor and no additions will be allowed to the Contract price.
- D. Before any cutting, patching, or finishing work is started, dust and moisture protection shall first be installed as required to protect adjacent construction and equipment and to prevent dust spreading from the immediate area where work is being performed.
- E. After any work is installed through any opening in walls, partitions, ceilings, or floors, the opening around the work shall be patched to match the existing construction, and the openings around pipe sleeves, and between pipes and sleeves shall be sealed watertight through floors and shall be sealed fireproof and smoke tight through floors, walls, partitions and ceilings.
- F. No structural member shall be cut without the approval of the Architect, and all such cutting shall be done in a manner directed by him.

3.2 FIRESTOPPING

- A. Firestopping is defined herein as the process of furnishing and installing a material, or combination of materials, in various constructions to maintain an effective barrier against the spread of flame, smoke, and gases and to retain the integrity of time-rated construction. It shall be used in specific locations as specified hereinafter.
 - 1. Other locations where specifically shown on drawings or where specified in other sections of these specifications.
 - 2. Openings in non-time-rated construction shall be closed with a compacted fill of ¾ LB density fiberglass and then sealed gas tight.
- B. Material of firestopping shall be asbestos free and capable of maintaining an effective barrier against flame, smoke and gases in compliance with the requirements of ASTM E 814, UL NO. 1479. Firestopping material shall be listed in the "Building Materials Directory" of UL as suitable for firestopping of penetrations made by steel, glass, plastic and insulated pipe. On insulated pipe, the classification must not require removal of insulation. The rating of the firestopping material shall not be less than the rating of the time-rated floor or wall assembly.
- C. Installation of fire stopping shall be in accordance with the manufacturer's recommendations and requirements. Surface to be in contact with firestopping shall be cleaned of dirt, grease, oil, loose materials, rust, or other substance that may affect proper fitting or the required fire resistance.
- D. Firestopping materials shall provide an effective barrier regardless of the geometric configurations of the void spaces. Firestopping materials for filling voids in floors having openings of four (4) inches or more shall be installed to support the same load as the floor is designed to support, unless the area is protected by a permanent barrier preventing loading or traffic on the firestopped area.

3.3 ELECTRICAL COORDINATION

- A. All control wiring, and safety interlock wiring required shall be furnished and installed as specified within these specifications. The control wiring shall include the furnishing and installation of all conduit, boxes, fittings, devices, accessories, wire, and connections required for complete and properly functioning systems. All wiring shall be installed in conduit, and all splices and connections shall be made in approved type enclosures or boxes.
 - 1. If motors or controls are not shown on the Electrical Drawings, it has been assumed that these motors and controls have been wired as part of a piece of package equipment, or that control wiring will be run by the Contractor.

END OF SECTION 220100

SECTION 220517 SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal fittings.
 - 3. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of wet areas 2 inches (50 mm) above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants.

3.2 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Using grout, seal the space around outside of sleeve-seal fittings.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system or Sleeve-seal fittings>.
2. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

SECTION 220518 ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Spaces: Split-casting brass type with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons using new materials.

END OF SECTION 220518

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SECTION 220523 GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Section Includes:
 - 1. Bronze ball valves.
- 1.2 ACTION SUBMITTALS
 - A. Product Data: For each type of valve indicated.
- 1.3 QUALITY ASSURANCE
 - A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
 - B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
 - C. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

- 2.1 GENERAL REQUIREMENTS FOR VALVES
 - A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - B. Valve Sizes: Same as upstream piping unless otherwise indicated.
 - C. Valve Actuator Types:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
 - D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - E. Valve-End Connections:
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - 2. Threaded: With threads according to ASME B1.20.1.
 - F. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BRONZE BALL VALVES
 - A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:

3.2 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball valves.
 - 2. Throttling Service: Ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, bronze with bronze trim.

END OF SECTION 220523

SECTION 220529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Equipment supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
 - 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 3. Standard: MFMA-4.
 - 4. Channels: Continuous slotted steel channel with in-turned lips.
 - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 - 7. Paint Coating: Vinyl.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carpenter & Paterson, Inc.
 - 2. National Pipe Hanger Corporation.
 - 3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 4. Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- 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. Attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- K. Insulated Piping:
 - 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 allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for [trapeze pipe hangers] [and] [equipment supports].
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 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 a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- J. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

- K. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION 220529

SECTION 220 48 VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ace Mountings Co., Inc.
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth, Ribbed or Waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, Ribbed or Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ace Mountings Co., Inc.
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

3.3 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

- C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

END OF SECTION 220548

SECTION 220553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of [50 feet (15 m)] along each run. Reduce intervals to [25 feet (7.6 m)] in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Pipe Label Color Schedule:
 - 1. Domestic Water Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.
 - 2. RO Water Piping:

- a. As directed by the facility
- 3. Cooling Supply and Return Water Piping:
 - a. As directed by the facility

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. 1-1/2 inches (38 mm), round.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

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SECTION 220719 PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 ACTION 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).

1.3 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.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.

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. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. 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).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. 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).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. 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).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. 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).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches (75 mm).
2. Thickness: 11.5 mils (0.29 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. 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. Width: 3 inches (75 mm).
2. Thickness: 6.5 mils (0.16 mm).
3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches (50 mm).
2. Thickness: 3.7 mils (0.093 mm).
3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.7 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers, :
 - 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures, :
 - 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

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.
- 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.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm) 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 (100 mm) 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. 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 (50 mm) 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 (50 mm).
 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.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies.

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. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. 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.

3.6 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 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.
- C. 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.

3.7 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 (150 mm) 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 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.
 - C. 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.
- 3.8 FIELD QUALITY CONTROL
- A. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- 3.9 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. Underground piping.
 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- 3.10 INDOOR PIPING INSULATION SCHEDULE
- A. Domestic Cold Water: : One inch thick with a thermal resistance value (R-value): 2.
 1. All sizes: Insulation shall be the following: type I, preformed miner-fiber.
 - B. Domestic Hot and Recirculated Hot Water: One inch thick with a thermal resistance value (R-value): 3.6.
 - a. Insulation shall be the following: type I, preformed miner-fiber.
 - C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 1. All Pipe Sizes: Insulation shall be 1-inch (25 mm) thick preformed, type I mineral-fiber with field-applied PVC jacket.
- 3.11 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. Piping, Concealed:
 1. None.
 - C. Piping, Exposed:
 1. PVC: 20 mils (0.5 mm) thick.

END OF SECTION 220719

SECTION 221116 DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aboveground domestic water pipes, tubes, and fittings inside buildings.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Copper Unions:
 1. MSS SP-123.
 2. Cast-copper-alloy, hexagonal-stock body.
 3. Ball-and-socket, metal-to-metal seating surfaces.
 4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys.
- B. Flux: ASTM B 813, water flushable.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Piping Specialties Products.
 - c. Viking Johnson.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Watts; a division of Watts Water Technologies, Inc.
 - c. Wilkins; a Zurn company.
 2. Standard: ASSE 1079.
 3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 4. End Connections: Solder-joint copper alloy and threaded ferrous.

- C. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
 2. Standard: IAPMO PS 66.
 3. Electroplated steel nipple complying with ASTM F 1545.
 4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
 5. End Connections: Male threaded or grooved.
 6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install shutoff valve immediately upstream of each dielectric fitting.
- C. Install domestic water piping level and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- G. Install piping to permit valve servicing.
- H. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- L. Install sleeves for piping penetrations of walls, ceilings, and floors.
- M. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

- 1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- 2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

- B. Domestic water piping will be considered defective if it does not pass tests and inspections.

- C. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Perform the following adjustments before operation:

- 1. Close drain valves, hydrants, and hose bibbs.
- 2. Open shutoff valves to fully open position.
- 3. Open throttling valves to proper setting.
- 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
- 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) 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 (200 mg/L) 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. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.9 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Fitting Option: Braze joints may be used on aboveground copper tubing.
- C. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast or wrought-copper, solder-joint fittings; and soldered joints.
- D. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:
 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B cast or wrought-copper, solder-joint fittings; and braze joints.
- E. Below grade, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:
 1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and braze joints.

END OF SECTION 221116

SECTION 221117 – PROCESS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General provisions of the Sections, "Plumbing General Provisions," apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel pipe and fittings.
 - 2. CPVC piping.
 - 3. Piping joining materials.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF Standard 372 for low lead.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe:
 - 1. ASTM A 53/A 53M, Type E, Grade B, Standard Weight.
 - 2. Include ends matching joining method.
- B. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- C. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable-Iron Unions:
 - 1. ASME B16.39, Class 150.
 - 2. Hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
 - 4. Threaded ends.

2.3 CPVC PIPING

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 80.
 - 1. CPVC Socket Fittings: ASTM F 439 for Schedule 80.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

2.4 PIPING JOINING MATERIALS

- A. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
- B. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 CPVC VALVES

- A. Ball Valves:
 - 1. Description:
 - a. Standards: MSS SP-122 and comply with ASTM F 1970.
 - b. Pressure Rating: 150 psig (1035 kPa) at 73 deg F (23 deg C) .
 - c. Body Material: ASTM D 1784, CPVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D 1784, CPVC compound.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D 1784, CPVC compound.
 - j. Stem Seals: EPDM-rubber O-rings.

- k. Handle: Tee shaped.
- B. Swing-Check Valves:
 - 1. Description:
 - a. Standard: Comply with ASTM F 1970.
 - b. Pressure Rating: 150 psig (1035 kPa) at 73 deg F (23 deg C) .
 - c. Body Material: ASTM D 1784, CPVC compound.
 - d. Body Design: Bolted-bonnet type.
 - e. End Connections: Flanged.
 - f. Shaft: ASTM D 1784, CPVC compound.
 - g. Disc and Arm: ASTM D 1784, CPVC compounds.
 - h. Gasket and Seals: EPDM rubber.

2.6 QUICK COUPLINGS

- A. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- B. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug End: Straight-through type with barbed outlet for attaching hose.
- C. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
 - 2. Plug End: With barbed outlet for attaching hose.

2.7 HOSE ASSEMBLIES

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig (2070-kPa) minimum working pressure, unless otherwise indicated.
 - 1. Hose: Reinforced single-wire-braid, CR-covered hose for compressed-air service.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install process water piping level with 0.25 percent slope downward toward drain and plumb.
- C. Install air and drain piping with 1 percent slope downward in direction of flow.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Piping: Join according to ASTM D 2855.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
- D. Install supports for vertical steel piping every 15 feet (4.5 m).
- E. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
- F. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.

3.4 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 2. Water Piping Tests:
 - a. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - B. Compressed Air Tests and Inspections:
 - 1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa) . Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 2. Repair leaks and retest until no leaks exist.
 - C. Prepare test and inspection reports.
- 3.6 CLEANING
- A. Clean water piping as follows:
 - 1. Purge new piping before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
- 3.7 PIPING SCHEDULE
- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - B. Aboveground process water piping, NPS 2 (DN 50) and smaller, shall be the following:
 - 1. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
 - C. Compressed-Air Distribution Piping: Use the following piping materials for each size range:
 - 1. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.

END OF SECTION 221117

SECTION 221316 SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
- D. Solvent Cement: ASTM D 2564.

PART 3 - EXECUTION

3.1 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 coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.
- G. Install piping to allow application of insulation.
- 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 two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install soil and waste drainage and vent piping 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.
- K. Install underground PVC piping according to ASTM D 2321.
- L. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 2. Install drains in sanitary drainage gravity-flow piping.
- M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors.
- O. Install sleeve seals for piping penetrations of concrete walls and slabs.
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors.
- 3.2 JOINT CONSTRUCTION
- A. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.
- 3.3 CONNECTIONS
- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- 3.4 FIELD QUALITY CONTROL
- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (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.

3.5 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.6 PIPING SCHEDULE

- A. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be solid wall PVC pipe, PVC socket fittings and solvent-cemented joints.
- B. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be solid wall PVC pipe, PVC socket fittings and solvent-cemented joints.
- C. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316

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SECTION 221319 SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof flashing assemblies.
 - 2. Miscellaneous sanitary drainage piping specialties.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

PART 2 - PRODUCTS

2.1 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 - 1. Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - a. Open-Top Vent Cap: Without cap.

2.2 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
 - b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.
- B. Trap Guards:
 - 1. Proset Systems "trap guard". Flexible elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom. Designed to allow waste water to open and adequately discharge floor drain through its interior. Device to close and return to original molded shape after waste water discharge is complete.
- C. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- D. Stack Flashing Fittings:
 - 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- E. Expansion Joints:
 - 1. Standard: ASME A112.21.2M.
 - 2. Body: Cast iron with bronze sleeve, packing, and gland.
 - 3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 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 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. 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 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
 - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
 - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) 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.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- J. Install wood-blocking reinforcement for wall-mounting-type specialties.
- K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings.
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

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SECTION 223300 ELECTRIC DOMESTIC WATER HEATER

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following water heaters:
 - 1. Commercial, electric, storage, domestic-water heaters.

1.2 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: For each type of commercial water heater, signed by product manufacturer.
- D. Operation and Maintenance Data: For water heaters to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that have failed in material or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 TANK STYLE WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradford White Corporation.
 - b. Rheem Manufacturing Company.
 - c. State Industries.
 - 2. Standard: UL 1453.
 - 3. Storage-Tank Construction: Non-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 (1035 kPa).
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 4. 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 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 domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
5. Special Requirements: NSF 5 construction.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL Inc.
 - b. State Industries.
 - c. Taco, Inc.
- 2. 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.
- 3. 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.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- B. Install electric, domestic-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.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- C. 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.
- D. 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 electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."
- E. Fill electric, domestic-water heaters with water.
- F. Charge domestic-water compression tanks with air.
- G. Install electric supply to water heaters according to NEC.

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.

END OF SECTION 223300

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SECTION 230100 GENERAL PROVISIONS

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 the work in Division 23 – Mechanical Work.
- B. This Section is hereby made a part of all other sections of Division 23 – Mechanical Work, as if repeated in each.

1.2 DESCRIPTION OF WORK

- A. Provide items, articles, materials, operation and methods required by drawings and specifications including labor, equipment, supplies and incidentals necessary for completion of work in Division 23 - Mechanical Section.
 - 1. Record documents.
 - 2. Coordination drawings.

1.3 QUALITY ASSURANCE

- A. All permits, licenses and fees that are required by governing authorities for the performance of the work shall be procured and paid for by the Contractor.
- B. All work shall be performed in compliance with all applicable and governing safety regulations including the regulations of the Occupational and Safety Health Act. All safety lights, signs and guards required for performance of work shall be provided by the Contractor.
- C. All work shall conform to the requirements of all applicable codes, ordinances and regulations including the rules and regulations of the National Electrical Code, the National Fire Protection Association, the 2012 International Building Code, 2012 International Mechanical and Plumbing Code, O.S.H.A. and all State and local laws, codes and ordinances.
- D. Laws, codes, ordinances and regulations shall take precedent excepting only where the work called for by the drawings and specifications exceeds by quality and quantity.
- E. Fixtures, appliances, equipment and materials, which are subject to Underwriter's Laboratory tests, shall bear such approval.
- F. Manufacturer's listed in the equipment schedules are intended to establish quality only and does not limit equal products by other manufacturers. Mechanical and electrical designs are based on the requirements for the specified manufacturers listed on the equipment schedules. Conduit, disconnects, motor starters, breakers, fuses and wire sizes are selected on basis of scheduled equipment. Increased current requirements necessitating larger wire, breakers, switches, etcetera, to accommodate any alternate or substitute manufacturer's equipment, other than as shown on drawings shall be provided without any increase in contract price by Contractor furnishing the equipment.
- G. Manufacturers, where specifically called for, must provide factory tests, unit installation observations, unit start-up and tests, etcetera, as specified, and submit signed reports to the Construction Inspector upon completion of these services. Subletting of these services will not be permitted. Shop drawing submittals shall be accompanied with a letter of certification by the manufacturer that the specified services shall be provided. Failure to do so shall be cause to reject the shop drawing submittals.
- H. The contract drawings are in part schematic and intended to convey the scope of work and indicate the general layout, design and arrangement. The Contractor shall follow these drawings in the layout of his work and shall consult general construction drawings, electrical drawings and all other drawings for this project, and shall verify all existing site conditions to determine all conditions affecting the work shown or specified. The contract drawings are not to be scaled and the Contractor shall verify spaces in which the work is to be installed.
- I. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, Architect shall be notified before proceeding with installation.
- J. Work in cooperation with one another to fit piping and ductwork into the structure as job conditions may demand. All final decisions as to right of way and run of pipe, ducts, etcetera to be made by Construction Inspector or his representative.
- K. All work shall be performed by trained mechanics of a particular trade involved and done in a neat and workmanlike manner as approved by the Architect.
 - 1. Work shall be performed in cooperation with other trades and scheduled to allow timely and efficient completion of project.

2. Furnish other trades advance information on locations and sizes of frames, boxes, sleeves and openings needed for work, and also furnish information and shop drawings necessary to permit other trades affected to install their work properly without delay.
3. Where there is evidence that work of one trade will interfere with work of other trades, all trades shall assist in working out space conditions to make satisfactory adjustments.
- L. Work installed before coordinating with other trades causing interference with work of such other trades shall be changed to correct such condition without increase in contract price and as directed by the Architect.
- M. Where specific details and dimensions are not shown on the drawings, the Contractor shall take measurements and make layouts for the proper installation of the work and coordination with all other work on the project. In case of any discrepancies between the drawings and the specifications, it shall be assumed, by the signing of the Contract, that the higher cost (if any difference in costs) is included in the contract price, and the Contractor shall perform the work in accordance with the drawings or with the specifications, as determined and approved by the Construction Inspector.
- N. Definitions:
 1. "Piping" includes, in addition to pipe, all fittings, valves, sleeves, hangers, and other supports and accessories related to such piping.
 2. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, or in crawl spaces.
 3. "Exposed" means not installed underground or "concealed" as defined above.
 4. The words "furnish and install", "provide", "furnish", "install", or equivalent words are used or are understood, to mean the Contractor shall furnish and completely install the system, service, equipment, or material named, together with other associated devices, equipment, material, wiring, piping, etcetera as required for a complete operating installation, and conforming to the manufacturer's standards and recommendations.
 5. It is the intent of the Mechanical specifications and drawings to call for finished work, tested and ready for operation.
 - a. All apparatus, appliances, materials or work not shown on drawings, but mentioned in specifications, or vice versa, and/or all incidental accessories necessary to make work complete and ready for operation, even though not specified or shown on drawings, shall be furnished and installed without increase in contract price.
 - b. Should there be discrepancies or questions of intent, refer matter to Construction Inspector in writing for decision before ordering any equipment or materials, or before starting any related work.

1.4 RECORD DOCUMENTS

- A. Within 90 days after the date of system acceptance, provide record documents and indicate installed conditions for:
 6. Ductwork and piping systems, size and location, for both exterior and interior with terminal air or water design flow rates.
 7. Locations of control devices and balancing damper and valve final setpoint positions.
 8. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 9. Approved substitutions, Contract Modifications, and actual equipment and materials installed with performance data.

1.5 COORDINATION

- A. Prepare coordination drawings to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 1. Indicate the proposed locations of ductwork, piping, equipment, and materials. Include the following:
 - a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
 - b. Exterior wall and foundation penetrations.
 - c. Fire-rated wall and floor penetrations.
 - d. Equipment connections and support details.
 - e. Sizes and location of required concrete pads and bases.
 2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, sprinklers, and other ceiling-mounted devices.
- B. 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

- A. All materials and equipment shall be new and shall bear manufacturer's name, model number, serial number, date of manufacture and other identification marking.
- B. All materials and equipment shall be standard product of manufacturer regularly engaged in production of required type of material or equipment for at least 5 years (unless specifically exempted by the Construction Inspector) and shall be manufacturer's latest design having published properties.

2.2 ELECTRICAL EQUIPMENT

- A. General: Unless specified or shown otherwise, the Contractor shall furnish required motors for equipment furnished in the Mechanical Work. Motors shall be provided where indicated and as required for operation of the equipment being furnished. Motors shall be designed for full voltage starting unless otherwise specified or noted on drawings and shall be suitable for continuous duty at 40°C. ambient and at altitude of 3300 feet (1000 m) above sea level. All motors shall be selected, designed and fabricated in conformance with the requirements of NEMA MG 1 standard.
- B. Comply with IEEE 841 for severe-duty motors.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

- A. The responsibility for any cutting of construction, which is required for the installation work, shall be by the Contractor. The Contractor shall coordinate with the Architect before any cutting and obtain approval prior to any cutting.
 1. Where openings for mechanical work are provided under other sections of the specifications, this Contractor shall be responsible for locating and providing the proper dimensions for all such openings.
- B. Cutting shall be done with extreme care and in such a manner that the strength of the structure will not be endangered. Wherever possible, openings in concrete or masonry construction shall be by concrete saw or rotary core drill. Openings in any construction shall be cut the minimum size required for the installation of the work.
 1. Adequate protection shall be provided to prevent damage to adjacent areas and to prevent dust from spreading to adjacent areas.
 2. The use of jack hammers will not be permitted.
- C. Where openings or holes are cut in existing construction and the cutting breaks existing electrical circuitry or control circuitry, or communications, conduit and wiring, then it shall be the responsibility of the Contractor to have the circuitry, conduit and rewiring re-routed and to complete the circuitry as required and as approved by the Owner. Temporary completion shall be provided where necessary before the permanent re-routing and completion work is finished. All costs for this work shall be the responsibility of the Contractor and no additions will be allowed to the Contract price.
- D. Before any cutting, patching, or finishing work is started, dust and moisture protection shall first be installed as required to protect adjacent construction and equipment and to prevent dust spreading from the immediate area where work is being performed.
- E. After any work is installed through any opening in walls, partitions, ceilings, or floors, the opening around the work shall be patched to match the existing construction, and the openings around pipe sleeves, between pipes and sleeves, and around ductwork shall be sealed watertight through floors and shall be sealed fireproof and smoke tight through floors, walls, partitions and ceilings.
- F. No structural member shall be cut without the approval of the Architect, and all such cutting shall be done in a manner directed by him

3.2 FIRESTOPPING

- A. Firestopping is defined herein as the process of furnishing and installing a material, or combination of materials, in various constructions to maintain an effective barrier against the spread of flame, smoke, and gases and to retain the integrity of time-rated construction. It shall be used in specific locations as specified hereinafter.
 - 1. Piping penetrations through floor slab and through time-rated partitions or fire walls.
 - 2. Hanger penetrations through fire rated lid.
 - 3. Opening between floor slabs and curtain walls, including inside hollow curtain walls at the floor slab.
 - 4. Penetrations of vertical service shafts.
 - 5. Openings and penetrations in enclosures with time-rated fire doors.
 - 6. Other locations where specifically shown on drawings or where specified in other sections of these specifications.
 - 7. Openings in non-time-rated construction shall be closed with a compacted fill of $\frac{3}{4}$ LB density fiberglass and then sealed gas tight.
- B. Material of firestopping shall be asbestos free and capable of maintaining an effective barrier against flame, smoke and gases in compliance with the requirements of ASTM E 814, UL NO. 1479. Firestopping material shall be listed in the "Building Materials Directory" of UL as suitable for firestopping of penetrations made by steel, glass, plastic and insulated pipe. On insulated pipe, the classification must not require removal of insulation. The rating of the firestopping material shall not be less than the rating of the time-rated floor or wall assembly.
- C. Installation of fire stopping shall be in accordance with the manufacturer's recommendations and requirements. Surface to be in contact with firestopping shall be cleaned of dirt, grease, oil, loose materials, rust, or other substance that may affect proper fitting or the required fire resistance.
- D. Firestopping materials shall provide an effective barrier regardless of the geometric configurations of the void spaces. Firestopping materials for filling voids in floors having openings of four (4) inches or more shall be installed to support the same load as the floor is designed to support, unless the area is protected by a permanent barrier preventing loading or traffic on the firestopped area.

3.3 ELECTRICAL COORDINATION

- A. All control wiring, safety interlock wiring, and temperature control system wiring required shall be furnished and installed as specified within these specifications. The control wiring shall include the furnishing and installation of all conduit, boxes, fittings, devices, accessories, wire, and connections required for complete and properly functioning systems. All wiring shall be installed in conduit, and all splices and connections shall be made in approved type enclosures or boxes.
 - 1. If motors or controls are not shown on the Electrical Drawings, it has been assumed that these motors and controls have been wired as part of a piece of package equipment, or that control wiring will be run by the Contractor.
- B. Reports: The Contractor shall submit to the Architect, after mechanical systems are completely installed and operating under normal load conditions and prior to final acceptance of the project, four (4) copies of tabulated report on each piece of mechanical equipment motor and motor starter. The tabulated reports shall show the following information:
 - 1. Mechanical equipment identification on which motor and starter is used.
 - 2. Motor nameplate horsepower, full load amperes, and voltage.
 - 3. Motor nameplate service factor and temperature rise.
 - 4. Actual (metered) motor running amperes and voltage.
 - 5. Motor starter nameplate H.P. rating and voltage.
 - 6. Motor starter thermal overload protection unit current rating, manufacturer's name and manufacturer's catalog number marked on thermal units.

END OF SECTION 230100

SECTION 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Class B.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

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.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE 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.

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION 230513

SECTION 230517 SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 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 (50 mm) above finished floor level.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150) : Cast-iron wall sleeves.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves.
 - 2. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Interior Partitions:
 - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Roof curbs.
 - 7. Equipment supports.

1.2 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.

1.3 ACTION SUBMITTALS

- A. Submit Product Data: for each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Metal framing systems.
 - 2. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

PART 2 - PRODUCTS

2.1 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 2. Standard: MFMA-4.
 - 3. Channels: Continuous slotted steel channel with inturned lips.
 - 4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel>.
 - 6. Metallic Coating: Electroplated zinc.

2.2 ROOF CURBS

- A. Manufacturers: Subject to compliance with requirements,[provide products by one of the following:
 - 1. Custom Curb.
 - 2. Pate Manufacturing Company: PC-5.
 - 3. Thycurb.
- B. Construction
 - 1. Curbs for roof mounted equipment shall be of monolithic construction, not less than 0.047 inch (1.2 mm) thick galvanized steel, with continuous welded corner seams, factory installed wood nailer no cant construction with base as required for attaching to the roof structure.
 - 2. Curbs shall be internally insulated with 1½" thick, 3 lb. density rigid glass fiber board and shall have galvanized sheet metal liner.
 - 3. Curbs shall be of size as required to properly mate with equipment to be mounted and shall be designed and constructed to safely support the weight of the equipment.
 - 4. The curbs shall be securely attached to the roof structure to withstand wind pressures on the vertical surface of the curb or supports and the mounted equipment by wind velocities up to 100 MPH.

2.3 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
- B. Equipment supports shall have integral base plate, wood nailer, and 18 gauge galvanized steel flashing cap.

2.4 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 ROOF CURBS

- A. All equipment and materials shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and suitable for the service required.
- B. The complete installation shall be made watertight and shall be coordinated with the roofing installer.
- C. Items with hinged bases shall be furnished with padlock hasps for padlocking. The anchoring of the hasp components shall be such that they cannot be removed when in the locked position

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M 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 so contours of welded surfaces match adjacent contours.

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 a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- D. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION 230529

SECTION 230548 VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
- 2. Size: Factory or field cut to match requirements of supported equipment.
- 3. Pad Material: Oil and water resistant with elastomeric properties.
- 4. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
- 5. Infused nonwoven cotton or synthetic fibers.
- 6. Load-bearing metal plates adhered to pads.
- 7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, Ribbed or Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 - 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 230548

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SECTION 230553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Natural gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

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SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 2. Duct leakage tests.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB reports.
- C. Sample report forms from AABC, NEBB or TABB.
- D. Instrument calibration reports, to include the following: instrument type and make, serial number, application, dates of use and dates of calibration.

1.3 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Certified employee of the TAB specialist.
 - 2. TAB Technician: Certified employee of the TAB specialist certified as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Standard 62.1 Compliance: Verify the total outdoor air flow and space supply airflows meet ASHRAE Standard 62.1, as noted in Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA 90.1 Compliance: TAB Report showing balancing first to minimize throttling losses and then adjusted to meet flow conditions per Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves.
 - 1. 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.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine operating safety interlocks and controls on HVAC equipment.

- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Automatic temperature-control systems are operational.
 - g. Ceilings are installed.
 - h. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

- b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 4. Obtain approval from Owner and Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 5. 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 that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
 - B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
 - C. Adjust air inlets and outlets for each space to indicated airflows.
 - 1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 - 2. Measure inlets and outlets airflow.
 - 3. Adjust each inlet and outlet for specified airflow.
 - 4. Re-measure each inlet and outlet after they have been adjusted.
 - D. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.
- 3.6 PROCEDURES FOR MOTORS
- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
 - B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.
- 3.7 DUCT LEAKAGE TESTS
- A. Witness the duct pressure testing performed by the Mechanical Contractor/Installer.
 - B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
 - C. Report deficiencies observed.

3.8 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.9 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to 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; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Balancing stations.
 - 4. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - 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 (mm), and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor 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 (mm), and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch (mm) o.c.
 - f. Make and model number.
 - g. Face area in sq. ft. (sq. m).
 - h. Tube size in NPS (DN).
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Average face velocity in fpm (m/s).
 - c. Air pressure drop in inches wg (Pa).
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
 - e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
 - f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig (kPa).
 - j. Refrigerant suction temperature in deg F (deg C).
 - k. Inlet steam pressure in psig (kPa).
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.

- e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
- 2. Motor Data:
 - a. Motor 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 (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated airflow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual airflow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- I. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling 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.
 - h. Size.
 - i. Effective area in sq. ft. (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary airflow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final airflow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.

- e. Flowmeter type.
- 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Entering-air temperature in deg F (deg C).
 - c. Leaving-air temperature in deg F (deg C).
- K. Instrument Calibration Reports:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

END OF SECTION 230593

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SECTION 230713 DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply.
 - 2. Indoor, concealed return located in unconditioned space.
 - 3. Outdoor, exposed supply and return.

1.2 ACTION 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).

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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.
- B. VOC Content
 - 1. 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).
 - 2. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct 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. 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 vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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.
 - 1. 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).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 - 3. Solids Content: 60 percent by volume and 66 percent by weight.
 - 4. Color: White

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 2. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 3. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 40 to plus 121 deg C).
 4. Color: Aluminum.
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 4. Color: White.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches (75 mm).
 2. Thickness: 11.5 mils (0.29 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
 2. Thickness: 3.7 mils (0.093 mm).
 3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.8 SECUREMENTS

- A. Bands:
1. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) 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.
- 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 INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Extend insulation over all duct segments and accessories including coils, reheat coils, sound attenuators and dampers.
- D. 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.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- 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.
- 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) 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. Unlisted duct tape is not permitted as a sealant.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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 (50 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper and damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping".

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 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 either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. 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.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal. Unlisted duct tape is not permitted as a sealant.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
 - 5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
 - 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install 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 insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch (25-mm) 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.
- B. Where metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply.
 - 2. Indoor, concealed return.
 - 3. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 4. Fibrous-glass ducts.
 - 5. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 6. Factory-insulated flexible ducts.
 - 7. Flexible connectors.
 - 8. Vibration-control devices.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Thermal resistance values (R-values) shall be as follows:
 - 1. Supply Duct Above Ceiling in Non-plenum Spaces: $6 (^{\circ}\text{F}\cdot\text{h}\cdot\text{ft}^2)/\text{btu}$.
 - 2. Return Duct Above Ceiling in Non-plenum Spaces: $3.5 (^{\circ}\text{F}\cdot\text{h}\cdot\text{ft}^2)/\text{btu}$.
- B. Concealed, rectangular, supply-air duct insulation shall be mineral-fiber blanket.
- C. Concealed, rectangular, return-air duct insulation shall be mineral-fiber blanket.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation exposed to weather shall be suitable for outdoor service with a jacket or coating that is water retardant and provides shielding from solar radiation that can cause material degradation.
- B. Insulation materials and thermal resistances are identified below:
 - 1. Supply Duct: $6 (^{\circ}\text{F}\cdot\text{h}\cdot\text{ft}^2)/\text{btu}$.
 - 2. Return Duct: $3.5 (^{\circ}\text{F}\cdot\text{h}\cdot\text{ft}^2)/\text{btu}$.
- C. Exposed, round and flat-oval, supply-air duct insulation shall be mineral-fiber.
- D. Exposed, round and flat-oval, return-air duct insulation shall be mineral-fiber.
- E. Exposed, rectangular, supply and return-air duct insulation shall be mineral-fiber.

3.11 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. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
 - 1. Aluminum, Stucco Embossed: 0.024 inch (0.61 mm) thick.

END OF SECTION 230713

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SECTION 230900 INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.2 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
 - b. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
 - c. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
 - d. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
 - e. Relative Humidity: Plus or minus 5 percent.

1.3 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for control units, sensors and operator interface equipment.
 - 2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- 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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Written description of sequence of operation.
 - 4. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 - 5. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - 6. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Written description of sequence of operation including schematic diagram.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.6 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate supply of conditioned electrical branch circuits for control units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The new system and components shall be Johnson Controls Network Control System with Networked Control Engines and Networked Thermostat Controllers or approved equal alternate manufacturers.
 - 1. Siemens Eco-View
- B. Control system shall consist of smart thermostats, sensors, interface equipment, other apparatus, and accessories to control mechanical systems and to allow monitoring remotely through the web. The use of the web and system access shall be continuous and at no cost to the Owner after installation. Owner use of the system software shall be unrestricted and free of charge after the initial installation.

2.2 THERMOSTAT CONTROLLERS

- A. The networked thermostat controller shall be a BACnet networked device that provides control of rooftop units with or without economizers. The thermostat controller shall have the following functions and capabilities:
 - 1. Heat-cool-off switch.
 - 2. Fan on-auto switch.
 - 3. Fan-speed switch.
 - 4. Automatic changeover.
 - 5. Where used to automatically switch between heating and cooling, thermostats shall be capable of providing a temperature range or dead band of at least 5°F (adjustable) within which the supply of heating and cooling energy to the zones is shut off or reduced to a minimum.
 - 6. Exposed set point.
 - 1) Heating systems shall have the capability to adjust the setpoint down to 55°F or lower.
 - 2) Cooling systems shall have the capability to adjust the setpoint up to 90°F or higher or to prevent high space humidity levels.
 - 7. Exposed indication.
 - 8. Degree F indication.
 - 9. Thermostat shall provide at the following.
 - 1) Seven different time schedules per week. Programming shall be retained for at least ten hours during loss of power. Include an accessible manual override that allows temporary operation of the system for up to two hours.
 - 10. Automatic Start: The controls shall be capable of automatically adjusting the daily start time of the system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy.
 - 11. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
- B. Interface Requirements for HVAC Instrumentation and Control System:
 - 1. Interface relay for scheduled operation.
 - 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.

2.3 NETWORK CONTROL EQUIPMENT

- A. Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications with web-based user interface.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - 3. Standard Application Programs:
 - a. HVAC Control Programs: Supply-air reset, and enthalpy switchover.

- b. Programming Application Features: Include alarm processing and messaging; weekly, monthly, and annual scheduling and security access.
 - 4. Local Control Display: Connects to system bus and provides menu display and navigation keypad for monitoring status and controlling parameters on the integrated field controllers.
- B. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- C. Power Line Filtering: Internal or external transient voltage and surge suppression for controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
 - 5. Provide BACnet or LonWorks compatible interface for central HVAC control workstation for the following:
 - a. Adjusting set points.
 - b. Monitoring supply fan start, stop, and operation.
 - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature.
 - d. Monitoring occupied and unoccupied operations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install software in control units and control engine(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
- D. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Signal and communication cable:
 - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway.
 - 3. Install concealed cable in raceway.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
 - 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

B. DDC Verification:

1. Check network thermostat controllers operate the rooftop units in both heating and cooling mode.
2. Check network thermostat controller and rooftop unit to see that economizer cycle and exhaust/relief fans are energized at the appropriate outside air conditions.
3. Verify that RTU outside air dampers are open to the minimum position during heating and cooling mode and that outside air dampers are open to maximum position during economizer mode.
4. Verify that all alarms for each rooftop unit are identified and transmitted to the system.
5. Establish web-based access and control to verify that all system points are accessible and controllable.
6. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at controllers and panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate devices.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
6. Provide diagnostic and test instruments for calibration and adjustment of system.
7. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.5 DEMONSTRATION

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

END OF SECTION 230900

SECTION 230993 SEQUENCE OF OPERATION FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. HVAC Control Sequences described herein indicate the manner and chronological sequence in which, and methods by which, automatic temperature controls function.

1.2 PACKAGED ROOFTOP UNIT (RTU-1)

- A. This unit is a constant volume, DX cooling unit with natural gas-fired heating, fixed outside air for normal occupied mode. The packaged unit consists of outside air dampers, filters, gas furnace, DX evaporative coil, refrigerant compressors, condenser section, supply fan and exhaust/relief fan for economizer cycle.
- B. Start/Stop: The supply fan operation shall generally run continuously, but can be controlled from the space networked thermostat controller. When the fan is running, the OA damper shall be open to the minimum position (manually adjustable/set). Whenever the fan is off, all dampers shall assume their failed positions.
- C. Fan Speed: The supply fan speed shall be constant to maintain the supply air flow.
- D. Supply Air Temperature: A space networked thermostat controller shall monitor the air temperature and send an input signal to the rooftop unit unitary controls. The output signal from the unitary controls shall modulate the refrigeration compressors in the cooling mode and the gas heat in the heating mode to maintain the temperature set-point (adjustable). When the outside air temperature and relative humidity are at a point below the return air and the system is calling for cooling, the enthalpy controlled economizer shall modulate the economizer outside air damper, return air damper and relief air damper along with the refrigeration cycle in sequence to maintain the desired discharge air temperature (adjustable). The outside, return, and relief air damper shall modulate to maintain the preset mixed air temperature as sensed by the mixed air temperature sensor. Mixed air temperature set point shall be reset up as outside air temperature goes down.
- E. Safeties/Alarms:
 - 1. Low temperature shutdown: A unit supplied low temperature detection thermostat, manual reset, located downstream of the heat exchanger, will be hardwired to the fan circuit. Upon detection of a low temperature condition below 35°F (adj.) the supply fan will shut down, the outside air dampers will close and a low temperature alarm will be activated.
 - 2. Loss of Air Flow: When the pressure differential across the supply fan indicates a no air flow condition and the fan is commanded "ON" a fan failure alarm will be indicated at the remote control panel.
 - 3. Fire/Smoke Operation: When the duct mounted smoke detectors alarm, they will send a signal to the local fire alarm panel, which will signal an "alarm condition", the signal from the fire alarm panel will shut down the supply air fan.
- F. Demand Ventilation: With the unit in the occupied mode, the outside air damper shall be open to the minimum position and the unit shall operate in this manner unless demand ventilation is required or economizer cycle is activated. Demand ventilation will be implemented when the return air mounted CO2 sensor senses a CO2 level above the acceptable range. At that time, the outside air damper shall be commanded open to increase the percentage of outside air and lower the level of CO2 in the return air stream. The outside air shall modulate open to satisfy the CO2 sensor. Upon a drop in the level of CO2 to an acceptable level, the unit outside air damper shall modulate closed to the minimum position.
- G. Off Mode
 - 1. Occurs in the unoccupied mode.
 - 2. Supply fan is off and the outside air damper is closed.

1.3 PACKAGED ROOFTOP UNITS (RTU-2 & 3)

- A. These units are constant volume, DX cooling unit with natural gas-fired heating, fixed outside air for normal occupied mode. The packaged unit consists of outside air dampers, filters, gas furnace, DX evaporative coil, refrigerant compressors, condenser section, supply fan and exhaust/relief fan for economizer cycle.
- B. Start/Stop: The supply fan operation shall generally run continuously, but can be controlled from the space networked thermostat controller. When the fan is running, the OA damper shall be open to the minimum position (manually adjustable/set). Whenever the fan is off, all dampers shall assume their failed positions.
- C. Fan Speed: The supply fan speed shall be constant to maintain the supply air flow.
- D. Supply Air Temperature: A space networked thermostat controller shall monitor the air temperature and send an input signal to the rooftop unit unitary controls. The output signal from the unitary controls shall modulate the refrigeration compressors in the cooling mode and the gas heat in the heating mode to maintain the temperature set-point (adjustable). When the outside air temperature and relative humidity are at a point below the return air and the system is calling for cooling, the enthalpy controlled economizer shall modulate the economizer outside air damper, return air damper and relief air damper along with the refrigeration cycle in sequence to maintain the desired discharge air temperature (adjustable). The outside, return, and relief air damper shall modulate to maintain the preset mixed air temperature as sensed by the mixed air temperature sensor. Mixed air temperature set point shall be reset up as outside air temperature goes down.
- E. Safeties/Alarms:
 - 1. Low temperature shutdown: A unit supplied low temperature detection thermostat, manual reset, located downstream of the heat exchanger, will be hardwired to the fan circuit. Upon detection of a low temperature condition below 35°F (adj.) the supply fan will shut down, the outside air dampers will close and a low temperature alarm will be activated.
 - 2. Loss of Air Flow: When the pressure differential across the supply fan indicates a no air flow condition and the fan is commanded "ON" a fan failure alarm will be indicated at the remote control panel.
 - 3. Fire/Smoke Operation: When the duct mounted smoke detectors alarm, they will send a signal to the local fire alarm panel, which will signal an "alarm condition", the signal from the fire alarm panel will shut down the supply air fan.
- F. Off Mode
 - 1. Occurs in the unoccupied mode.
 - 2. Supply fan is off and the outside air damper is closed.

1.4 GENERAL BUILDING EXHAUST

- A. The exhaust fan shall run continuously and will be interlocked to run whenever the building is occupied.

1.5 MINI-SPLIT SYSTEMS

- A. These units are constant volume heating/cooling heat pumps with remote mounted thermostat control.
- B. Start/Stop: The operation of the supply fan shall be determined by a fan switch on the thermostat that allows either manual or automatic control. When the fan switch is in the manual "on" position, the supply fan shall run continuously. When the fan switch is in the automatic position, the supply fan shall cycle on and off with the mini-split fan coil unit to maintain temperature set point.
- C. Cooling Mode: Upon a space temperature greater than the room set point temperature, the mini-split system refrigeration compressor shall cycle on and off to maintain the set point temperature. Upon a drop in room temperature below the set point temperature, the supplemental electric resistance heat will be energized to warm the space. The supplemental heaters have integral thermostat controls.

1.6 HEAT AND VENTILATION OPERATING SEQUENCE

- A. Electric Unit Heater and Ventilation Fans:
 - 1. An electric temperature element shall monitor space temperature and control the electric unit heater and ventilation fan operation as follows:
 - a. During full heating the outside air damper will be fully closed and the ventilation fan shall be deactivated. As there is a call for heating, the electric unit heater shall be staged on and the heating element shall cycle to satisfy the space temperature set point.
 - b. During full ventilation, the outside air damper shall be fully open and the ventilation fan shall be activated. The control of this system shall be from the space thermostat. The ventilation system shall modulate to maintain the space set point.
 - c. There shall be a minimum 10 deg. deadband between the ventilation and heating setpoints. Ideally, the heating setpoint should be set at 55 deg. F and the ventilation setpoint should be set at 85 deg. F.

PART 2 - PRODUCTS

N/A

PART 3 – EXECUTION

N/A

END OF SECTION 230993

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SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping and tubing joining materials.
 - 3. Valves.

1.2 QUALITY ASSURANCE

- A. Each length of pipe and tubing and each pipe fitting utilized in a mechanical system shall bear the identification of the manufacturer.
- B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.3 PROJECT CONDITIONS

- A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Do not proceed with interruption of natural-gas service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig (862 kPa).
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 - 4. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- B. Bronze Plug Valves: MSS SP-78.
 - 1. Body: Bronze, complying with ASTM B 584.
 - 2. Plug: Bronze.
 - 3. Ends: Threaded, socket, or flanged.
 - 4. Operator: Square head or lug type.
 - 5. Pressure Class: 125 psig (862 kPa).
 - 6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- C. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

3.3 PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping concealed from view unless otherwise indicated.
- E. Install piping indicated to be exposed at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Locate valves for easy access.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Verify final equipment locations for roughing-in.
- J. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- K. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- M. Connect branch piping from top or side of horizontal piping.
- N. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- O. Do not use natural-gas piping as grounding electrode.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.6 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install piping adjacent to appliances to allow service and maintenance of appliances.
- C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.8 PAINTING

- A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: Gray.
- B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 PIPING SCHEDULE

- A. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.

3.11 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be the following:
 - 1. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be the following:
 - 1. Cast-iron, lubricated plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, full port, bronze ball valves with bronze trim.

2. Bronze plug valve.

END OF SECTION 231123

SECTION 233113 METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Duct liner.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Equipment installation based on equipment being used on Project.
10. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated. Duct sizes shown are air opening size.
- 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 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."

2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- 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 3-1, "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."
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round 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."
 - 1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) 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."

2.3 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 (Z275).
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Factory- or Shop-Applied Antimicrobial Coating:
 - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
 - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
 - 4. 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.
 - 5. Shop-Applied Coating Color: Black.
 - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- D. 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.
- E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.4 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. 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 (2500 Pa), 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.
 - C. 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.
 - D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
 - E. Round Duct Joint O-Ring Seals:
 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.
- 2.5 HANGERS AND SUPPORTS
- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
 - C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
 - D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
 - E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
 - F. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
- 2.6 DUCT LINER
- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - a. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) 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. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - 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. Insulation Pins and Washers:
 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - C. 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. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
7. 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 (12.7 m/s) or where indicated.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- 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.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed 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 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."

3.4 HANGER AND SUPPORT INSTALLATION

- 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.

- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "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 (610 mm) of each elbow and within 48 inches (1200 mm) 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 (5 m).
 - 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.
- 3.5 CONNECTIONS
- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
 - B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 3.6 PAINTING
- A. 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 Division 09 painting Sections.
- 3.7 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. Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - b. Return Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections totaling no less than 50 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.
 - C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
 - D. Duct system will be considered defective if it does not pass tests and inspections.
 - E. Prepare test and inspection reports.
- 3.8 DUCT CLEANING
- A. Clean new duct system(s) before testing, adjusting, and balancing.
 - B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
 - C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Coils and related components.
 4. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 5. Supply-air ducts, dampers, actuators, and turning vanes.
 6. Dedicated exhaust and ventilation components and makeup air systems.

3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to rooftop units:
 - a. Pressure Class: Positive 3-inch wg (1000 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Ducts Connected to rooftop units:
 - a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg (500 Pa).
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

F. Elbow Configuration:

- a. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
 - 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."
- b. Velocity 1500 fpm (7.6 m/s) 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."

G. 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 (5 m/s) or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
 - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.
 - H. Liner:
 - 1. Supply Air Duct drops from rooftop units: Fibrous glass, Type I, 1 inch (25 mm) thick.
 - 2. Return Air Duct drops from rooftop units: Fibrous glass, Type I, 1 inch (25 mm) thick.

END OF SECTION 233113

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SECTION 233300 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Control dampers.
 - 4. Turning vanes.
 - 5. Flexible connectors.
 - 6. Flexible ducts.
 - 7. Duct accessory hardware.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Submit manufacturer's catalog cuts and specifications for each type of manufactured ductwork accessory.
 - 2. Submit schedule showing manufacturer's figure number, size, location, rated capacities, and features for each control damper.
 - 3. Include pressure drop curve or chart for each type, and size of motorized control damper.
 - 4. Submit fire protection rating, maximum velocity/pressure ratings and manufacturer's installation instructions for each fire damper. Velocity/pressure ratings shall include both ducted and non-ducted data.
 - 5. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. 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.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 (Z180).
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- C. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Ruskin Company.
- B. Description: Gravity balanced.
- C. The damper assembly shall be suitable for operation from -40°F to 200°F, and air velocities of 2500 fpm (13 m/s). Maximum Air Velocity: 1000 fpm (5.1 m/s).
- D. Maximum backdraft airflow shall not exceed 12 CFM per square foot of damper at 0.5 in. w.g. static pressure differential. The maximum force required to fully open the backdraft damper shall not exceed 0.15 in. w.g. static pressure differential. Maximum System Pressure: 1-inch wg (0.25 kPa).
- E. Maximum leakage when tested in accordance with AMCA Standard 500 shall not exceed 20 cfm/ft² at 1.0 in. w.g..

- F. Frame: Hat-shaped, 0.09-inch- (2.3-mm-) thick extruded aluminum with welded corners or mechanically attached and mounting flange. Damper linkage shall be concealed within the frame construction.
- G. Blades: Multiple single-piece blades, center pivoted maximum 6-inch (150-mm) width, 0.050-inch- (1.2-mm-) thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.
- H. Blade Action: Parallel.
- I. Blade Seals: Extruded vinyl, mechanically locked.
- J. Blade Axles:
 - 1. Material: Nonferrous metal.
 - 2. Diameter: 0.20 inch (5 mm).
 - 3. Blades shall be fitted with synthetic bearings.
- K. Tie Bars and Brackets: Aluminum.
- L. Return Spring: Adjustable tension.
- M. Bearings: synthetic pivot bushings.
- N. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage (1.0 mm) minimum.
 - b. Sleeve Length: 6 inches (152 mm) minimum.
 - 6. Screen Mounting: Rear mounted.
 - 7. Screen Material: Galvanized steel.
 - 8. Screen Type: Bird.
 - 9. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

- A. Standard, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. Greenheck Fan Corporation.
 - c. Ruskin Company.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade damper blades shall be a maximum of 8 inches (200 mm) wide.
 - b. Opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
 - 6. Tie Bars and Brackets: Aluminum.
- B. Blade Axles:
 - 1. Size: 0.5-inch (13-mm) Galvanized steel hex with molded synthetic bearings.
 - 2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- C. Jackshaft:
 - 1. Size: 0.5-inch (13-mm) diameter square.
 - 2. Material: Galvanized-steel mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- D. Damper Hardware:
 - 1. Include factory mounted locking hand quadrant to hold single-blade dampers in a fixed position without vibration.
 - 2. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.

3. Include center hole to suit damper operating-rod size.
4. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Greenheck Fan Corporation.
 3. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage. Low leakage dampers shall have published leakage data certified under ACMA certified ratings program showing leakage does not exceed 20 cfm/ft² for non-motorized and 4 cfm/ft² for motorized ventilation air intake, exhaust or relief dampers at 1.0 in.w.g.
- C. Frames:
 1. Hat shaped.
 2. 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
 3. Mitered and welded corners.
- D. Blades:
 1. Multiple blade with maximum blade width of 6 inches (152 mm).
 2. Opposed-blade design.
 3. Galvanized-steel.
 4. 0.064 inch (1.62 mm) thick single skin.
 5. Blade Edging: Closed-cell neoprene.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- (13-mm-) square or hexagonal. Round axles are not acceptable. The material shall be stainless steel axles with blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
- F. Bearings:
 1. Molded synthetic.
 2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) 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 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Single thickness, curved blades of galvanized sheet steel; minimum 0.029 inch (0.7 mm) thick; non-adjustable, support with bars perpendicular to blades. Position and hold in place with pre-formed vane runners suitable for duct mounting.
 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall.
- E. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.7 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be tested in accordance with UL 181 and shall be listed and labeled as Class 0 or Class 1 flexible air connectors.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Closure systems, Coatings and Adhesives: Comply with UL 181, B.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.

3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor 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 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.8 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Thermaflex.
 4. Wiremold.
- B. Insulated, Flexible Duct: UL 181, Class 1, conforming to the requirements of NFPA 90A; factory fabricated, leak tight, black polymer film supported by and bonded to helically wound, spring-steel wire; fibrous-glass insulation; and puncture and scuff resistant vapor-barrier film.
 1. Pressure Rating: 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
 2. Maximum Air Velocity: 4000 fpm (20 m/s).
 3. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action to suit duct size.
 1. Closure systems used to seal flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked "181B-FX" for pressure-sensitive tape or "181B-M" for mastic. Mechanical fasteners shall be marked "181B-C."
- D. Flexible Duct Supports
 1. Steel straps not less than 1 inch (25mm) wide and .059 inch (1.5 mm) thick.
 2. Flexible duct connections to ceiling diffusers shall be made utilizing the "Flex Flow Elbow" brace that maintains a minimum radius of curvature and avoids kinks.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Visit job site prior to installation to verify all requirements, connections and conditions. Starting work indicates acceptance of other in-place work.
- B. Provide inserts and anchors into other work for the support of this work.
 1. Ensure these items are installed in the proper locations.
 2. Include fastening devices to attach work.
 3. Use the proper fasteners and anchors for the materials encountered and the operation and service of the equipment.
- C. Install all ductwork accessories in accordance with the manufacturer's instructions using workers skilled and familiar with the items and the installation specifications.
- D. Sequence the installation and erection of work to ensure mechanical and electrical connections are affected in an orderly and expeditious manner.
- E. Coordinate all cutting, fitting and patching with the other trades involved to ensure a complete and finished installation.

3.2 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. Install 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 dampers at inlet of all exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated. Backdraft dampers shall be mounted inside the roof curb for roof mounted exhaust fans.
- D. Where shown on plans, and where required to properly balance the airflow in the HVAC supply, return, and exhaust ductwork systems provide manual volume dampers. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Where shown on plans, in horizontal ducts passing through fire rated partitions and in vertical ducts passing through fire rated floors, furnish and install fire dampers. Install fire dampers according to UL listing.
 - 1. Rectangular ductwork shall be furnished with rectangular dampers. Dampers shall be Ruskin type IBD2, Style "C" frame with collars for rectangular ductwork connections.
 - 2. Round/flat-oval ductwork shall be furnished with round dampers. Round dampers shall be Ruskin type IBD2, Style "CR" frame with collars for round ductwork connections.
- H. Install flexible connectors to connect ducts to equipment.
- I. Flexible Duct
 - 1. Connect diffusers or light troffer boots to ducts with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.
 - 2. Flexible duct connections to rectangular ducts or plenum housings shall be made with spin-in fittings equipped as herein specified.
 - 3. The inner lining shall be secured in place to the spin-in fitting or round duct with nylon or steel draw-bands for an airtight connection. The insulation and outer vapor barrier jacket shall be drawn up to completely cover the connection and shall be secured in place with a second nylon or steel draw-band for a vapor-tight connection.
 - 4. Flexible ducts shall be supported with steel straps, the use of wire for the support of flexible ducts will not be allowed.

3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Inspect turning vanes for proper and secure installation.
 - 4. Operate remote damper operators to verify full range of movement of operator and damper.
 - 5. Ensure equipment is operational and complete in all respects, including all accessories. Verify that all dampers are in the proper position before starting equipment.

END OF SECTION 233300

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SECTION 233423 HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Centrifugal roof ventilators.
 - 2. Ceiling-mounted ventilators.

1.22 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also 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 thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.03 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.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Aerovent; a division of Twin City Fan Companies, Ltd.
 - 2. Greenheck Fan Corporation.
- B. Housing: Removable, spun-aluminum top; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted and factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops. Damper shall have a maximum leakage rate of 20 cfm /ft² at 1.0 in.w.g tested according to AMCA Standard 500.
- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
 - 1. Overall Height: 18 inches (450 mm).
 - 2. Pitch Mounting: Manufacture curb for roof slope.
 - 3. Metal Liner: Galvanized steel.

4. Items with hinged bases shall be furnished with padlock hasps for padlocking. The anchoring of the hasp components shall be such that they cannot be removed when in the locked position.

2.2 CEILING-MOUNTED VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Carnes Company.
 2. Greenheck Fan Corporation.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Aluminum louvered grille with flange on intake and thumbscrew attachment to fan housing.
- E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- F. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Isolation: Rubber-in-shear vibration isolators.
 3. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
- C. Support suspended units from structure using threaded steel rods and elastomeric hangers.
- D. Install units with clearances for service and maintenance.
- E. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. 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, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

END OF SECTION 233423

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SECTION 233713 DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square diffusers.
 - 2. Round ceiling diffusers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of 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.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular, Square and Round Ceiling Diffusers:
 - 1. Manufacturers: Subject to compliance with requirements, provide product indicated on the drawings or equal from one of the following manufacturers:
 - a. Carnes.
 - b. Krueger.
 - c. Price Industries.
 - 2. Material: Steel.
 - 3. Finish: Baked enamel, white.
 - 4. Face Size: As indicated on the drawings.
 - 5. Pattern: Adjustable.
 - 6. Dampers: Opposed blade.
- B. Sidewall Diffusers:
 - 1. Manufacturers: Subject to compliance with requirements, provide product indicated on the drawings or equal from one of the following:
 - a. Carnes.
 - b. Krueger.
 - c. Price Industries.
 - 2. Material: Steel.
 - 3. Finish: Baked enamel, white.
 - 4. Face Size: As indicated on the drawings..
 - 5. Pattern Controller: Adjustable louvered face.
 - 6. Dampers: Opposed blade.
- C. Fixed Face Grille:
 - 1. Manufacturers: Subject to compliance with requirements, provide product indicated on the drawings or equal from one of the following:
 - a. Carnes.
 - b. Krueger.
 - c. Price Industries.
 - 2. Material: Steel.
 - 3. Finish: Baked enamel, white.
 - 4. Face Size: As indicated on the drawings..
 - 5. Pattern Controller: Fixed louvered face.

2.2 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 practical. 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.

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 PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Hot-gas reheat.
 - 3. Gas-fired heating.
 - 4. Integral, space temperature controls.
 - 5. Economizer outdoor- and return-air damper section.
 - 6. Roof curbs.

1.2 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.3 QUALITY ASSURANCE

- A. AHRI Compliance:
 - 1. Comply with AHRI 203/110 and AHRI 303/110 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 or UL 1995 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- A. ASHRAE 62.1 Compliance:
 - 1. Airstream Surfaces: Non-sheet metal surfaces in contact with the airstream shall comply with requirements in Section 5.5.
 - a. Material surfaces shall be determined to be resistant to mold growth in accordance with a standardized test method, such as the "Mold Growth and Humidity Test" in UL 181, ASTM C 1338, or comparable test methods.
 - b. Airstream surface materials shall be evaluated in accordance with the "Erosion Test" in UL 181 and shall not break away, crack, peel, flake off or show evidence of delamination or continued erosion under test conditions.
 - 2. Particulate matter filters or air cleaners upstream of cooling coils or other wetted devices shall have a MERV of not less than 6 per Section 5.9.
 - 3. Finned-tube coils shall include access for cleaning or be selected to result in no more than 0.75 in. w.c. (187 Pa) pressure drop at a coil face velocity of 500 fpm (2.54 m/s) per Section 5.12.
 - 4. Access: Include access doors for inspection, cleaning and routine maintenance of ventilation system components per Section 5.14.
 - 5. Filters: Do not operate units designed to have filters without filters in place per Section 7.1.2.
 - 6. Protection of Materials per Section 7.1.3: Follow manufacturer's recommendations for the protection of materials from moisture in transit and on site. Porous materials with visible microbial growth shall not be installed. Nonporous materials with visible microbial growth shall be decontaminated.
 - 7. Ensure ventilation air distribution systems are clean of dirt and debris before system start-up per Section 7.2.4.
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
 - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 - 4. 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. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by an approved manufacturer.

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced single-wall insulated panels with access doors to allow for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
- C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 - 3. Liner Adhesive: Comply with ASTM C 916, Type I.
- D. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches (50 mm) deep and complying with ASHRAE 62.1.
 - 1. Drain Connections: Located at lowest point of pan and sized to prevent overflow. Threaded nipple both sides of drain pan.
 - 2. Pan-Top Surface Coating: Corrosion-resistant compound.
- E. Airstream Surfaces: Non-metal surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on a fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Finned-tube coils shall include access for cleaning or be selected to result in no more than 0.75 in. w.c. (187 Pa) pressure drop at a coil face velocity of 500 fpm (2.54 m/s) per ASHRAE 62, Section 5.12.
 - 3. Coil Split: Interlaced.
- B. Outdoor-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
- C. Hot-Gas Reheat Refrigerant Coil:
 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.

2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief and crankcase heater.
- B. Refrigeration Specialties:
 1. Refrigerant: R-410A.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Brass service valves installed in compressor suction and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

2.6 DAMPERS

- A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 1. Damper Motor: Modulating with adjustable minimum position.
 2. Relief-Air Damper: Gravity actuated with bird screen and hood.
 3. Damper Leakage: Maximum leakage tested in accordance with AMCA Standard 500: 4 cfm/ft² at 1.0 in.w.g.
 4. Outdoor air damper shall be adjustable to provide a fixed minimum outdoor air cfm for ventilation.
- B. Barometric Relief Damper: Parallel- or opposed-blade galvanized-steel damper mechanically fastened to cadmium plated galvanized steel operating rod. Provide with adjustable counter-balance control of relief air to allow the damper to open upon a positive pressure in the return air.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 1. Fuel: Natural gas.
 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.
- E. Safety Controls:
 1. Gas Control Valve: Single stage for smaller tonnage (5-ton and smaller) units. Two stage for larger tonnage (6.5-tons and larger) units.
 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

- A. Basic Unit Controls:
 1. Control-voltage transformer.

2. Unit mounted return air humidistat for control of hot-gas reheat coil.
 3. Unit mounted return air carbon dioxide sensor for control of demand ventilation.
 4. Wall-mounted thermostat as specified in SECTION 230900 "Instrumentation & Control for HVAC".
- B. DDC Controller:
1. Controller shall have volatile-memory backup.
 2. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
 - b. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F (4 deg C).
 3. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors, and operate hot-gas reheat 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.
 - b. Unoccupied Periods: Cycle compressor and condenser fans for cooling to maintain setback temperature.
 4. Hot-Gas Reheat-Coil Operation:
 - a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycle compressor.
 - b. Unoccupied Periods: Reheat not required.
 5. Gas Furnace Operation:
 - a. Occupied Periods: Cycle/Stage burner to maintain room temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
 6. Fixed Minimum Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to required percent.
 - b. Unoccupied Periods: Close the outdoor-air damper.
 7. Economizer Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to 10 percent fixed minimum intake, 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 (15 deg C). Use outdoor-air temperature to adjust mixing dampers. During economizer cycle operation, lock out cooling.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
 8. Carbon Dioxide Sensor Operation:
 - a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.10 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Low-ambient kit using condenser fans for operation down to 35 deg F (1.7 deg C).
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Coil guards of painted, galvanized-steel wire.
- E. Hail guards of galvanized steel, painted to match casing.

2.11 ROOF CURBS

- A. 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: 1-1/2 inches (38 mm).
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.

- b. 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.
 - c. 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.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- B. Curb Height: 24 inches (610 mm) unless indicated otherwise.
- C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site.

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 RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete equipment pad level and secure on curbs. Coordinate roof penetrations and flashing with roof construction. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.
 - 5. Install alternating layers of water resistant 5/8" thick gyp board and 6-inch thick fiberglass insulation inside roof curb for sound attenuation.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. 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.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. 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 compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Clean condenser coil and inspect for construction debris.
9. Remove packing from vibration isolators.
10. Inspect operation of barometric relief dampers.
11. Verify lubrication on fan and motor bearings.
12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Adjust fan belts to proper alignment and tension.
14. 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.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Calibrate thermostats.
18. Adjust and inspect high-temperature limits.
19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
20. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) 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.
21. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
22. 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.
23. 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.
24. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 237413

SECTION 238126 SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 PERFORMANCE REQUIREMENTS

- A. Unit Performance Ratings: Factory test to comply with AHRI 210/240 test procedure.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

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.
- B. ASHRAE 15 Compliance: Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE 62.1 Compliance:
 - 1. Airstream Surfaces: Non-sheet metal surfaces in contact with the airstream shall comply with requirements in Section 5.5.
 - a. Material surfaces shall be determined to be resistant to mold growth in accordance with a standardized test method, such as the "Mold Growth and Humidity Test" in UL 181, ASTM C 1338, or comparable test methods.
 - b. Airstream surface materials shall be evaluated in accordance with the "Erosion Test" in UL 181 and shall not break away, crack, peel, flake off or show evidence of delamination or continued erosion under test conditions.
 - 2. Particulate matter filters upstream of cooling coils or other wetted devices shall have a MERV of not less than 6 per Section 5.9.
 - 3. Finned-tube coils shall include access for cleaning or be selected to result in no more than 0.75 in. w.c. (187 Pa) pressure drop at a coil face velocity of 500 fpm (2.54 m/s) per Section 5.12.
 - 4. Access: Include access doors for inspection, cleaning and routine maintenance of ventilation system components per Section 5.14.
 - 5. Filters: Do not operate units designed to have filters without filters in place per Section 7.1.2.
 - 6. Protection of Materials per Section 7.1.3: Follow manufacturer's recommendations for the protection of materials from moisture in transit and on site. Porous materials with visible microbial growth shall not be installed. Nonporous materials with visible microbial growth shall be decontaminated.
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
 - 1. Label each unit with permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE/IESNA 90.1. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. LG
 2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.

2.2 INDOOR UNITS

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 206/110.
 3. Fan: Direct drive, centrifugal.
 4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230100 "Mechanical General Provisions."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - e. Mount unit-mounted disconnect switches on interior of unit.
 5. Condensate Drain Pans:
 - a. Fabricated with one percent slope to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face.
 - 2) Depth: A minimum of 1 inch (25 mm) deep.
 - b. Single-wall, stainless-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 6. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch (25 mm).
 - 3) Merv according to ASHRAE 52.2: 5
 - 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
 - 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.
- B. Variable-Frequency Controllers:
1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, three-phase induction motor by adjusting output voltage and frequency.
 2. Output Rating: Three-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
 3. Unit Operating Requirements:
 - a. Input-frequency tolerance of 06/11 Hz, plus or minus 6 percent.
 - b. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - c. Minimum Displacement Primary-Side Power Factor: 96 percent.
 - d. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 - e. Starting Torque: 100 percent of rated torque or as indicated.

- f. Speed Regulation: Plus or minus 1 percent.
- 4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
- 5. Internal Adjustability Capabilities:
 - a. Minimum Speed: 5 to 25 percent of maximum rpm.
 - b. Maximum Speed: 80 to 100 percent of maximum rpm.
 - c. Acceleration: 2 seconds to a minimum of 22 seconds.
 - d. Deceleration: 2 seconds to a minimum of 22 seconds.
 - e. Current Limit: 50 percent to a minimum of 110 percent of maximum rating.
- 6. Self-Protection and Reliability Features:
 - a. Input transient protection by means of surge suppressors.
 - b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 - c. Adjustable motor overload relays.
 - d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - e. Instantaneous line-to-line and line-to-ground overcurrent trips.
 - f. Loss-of-phase protection.
 - g. Reverse-phase protection.
 - h. Short-circuit protection.
 - i. Motor overtemperature fault.
- 7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads, spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- 8. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.
- 9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- 10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back, based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- 11. Door-mounted, digital status lights shall indicate the following conditions:
 - a. Power on.
 - b. Run.
 - c. Overvoltage.
 - d. Line fault.
 - e. Overcurrent.
 - f. External fault.
- 12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed-time meter.
- 13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected, to indicate the following controller parameters:
 - a. Output frequency (Hertz).
 - b. Motor speed (rpm).
 - c. Motor status (running, stop, fault).
 - d. Motor current (amperes).
 - e. Motor torque (percent).
 - f. Fault or alarming status (code).
 - g. Proportional-integral-derivative feedback signal (percent).
 - h. DC-link voltage (volts dc).
 - i. Set-point frequency (Hertz).
 - j. Motor output voltage (volts).
- 14. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
- 15. Accessories:
 - a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
 - b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
 - c. Standard Displays:
 - 1) Output frequency (Hertz).
 - 2) Set-point frequency (Hertz).

- 3) Motor current (amperes).
- 4) DC-link voltage (volts dc).
- 5) Motor torque (percent).
- 6) Motor speed (rpm).
- 7) Motor output voltage (volts).

2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in manufacturer's standard color with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Manufacturer's standard inverter duty type.
 - b. Refrigerant Charge: R-410A.
 - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with AHRI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to -17 deg F.

2.4 ACCESSORIES

A. Thermostat: Wall mounted, wire-less to control multiple evaporators with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.
5. Thermostat shall provide the following.
 - a. Seven different time schedules per week. Programming shall be retained for at least ten hours during loss of power. Include an accessible manual override that allows temporary operation of the system for up to two hours.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Condensate drain, inline pump, field wired through the single point electrical connection.

D. 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.

E. Additional Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor cooling load.
3. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install compressor-condenser components on equipment support pads/rails. Anchor units to supports with removable, cadmium-plated fasteners.
- D. 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 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Pipe condensate pump discharge to nearest floor utilizing rigid copper drain pipe and fittings.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. 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.

END OF SECTION 238126

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SECTION 260100 BASIC ELECTRICAL REQUIREMENTS

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.
- B. See Section "Basic Electrical Materials and Methods," for materials and methods common to the remainder of this Division plus general related specifications including access to electrical installations.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for electrical installations. Administrative and procedural requirements are included in this Section to expand the requirements specified in the General Requirements.

1.3 DEFINITIONS

- A. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, or in crawl spaces.
- B. "Exposed" means not installed underground or "concealed" as defined above.
- C. The words "furnish and install", "provide", "furnish", "install", or equivalent words are used or are understood, to mean the Contractor shall furnish and completely install the system, service, equipment, or material named, together with other associated devices, equipment, material, wiring, piping, etc. as required for a complete operating installation, and conforming to the manufacturer's standards and recommendations.
- D. It is the intent of the Electrical specifications and drawings to call for finished work, tested and ready for operation.
 - 1. All apparatus, appliances, materials or work not shown on drawings, but mentioned in specifications, or vice versa, and/or all incidental accessories necessary to make work complete and ready for operation, even though not specified or shown on drawings, shall be furnished and installed without increase in contract price.
 - 2. Should there be discrepancies or questions of intent, refer matter to Construction Inspector in writing for decision before ordering any equipment or materials, or before starting any related work.

1.4 CLOSEOUT SUBMITTALS

- A. Prepare maintenance manuals in accordance with Division 1 for the Owner and include the following information for equipment items:
 - 1. Submittal data stating equipment rating, selected options, performance curves, engineering data and tests for each piece of equipment requiring maintenance, lighting and controls.
 - 2. A complete narrative of how each system is intended to operate. Include normal operating characteristics, recommended settings and limitations.
 - 3. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions for each piece of equipment requiring maintenance. Maintenance procedures for routine preventative maintenance shall be clearly identified. Include relamping, recalibration of controls, troubleshooting; disassembly, repair, and reassemble; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.
 - 5. Complete nomenclature and commercial numbers of replacement parts.
 - 6. Names and addresses of at least one qualified service agency.
- B. Record Drawings: Within 30 days after the date of system acceptance, provide record drawings of the actual installation in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, include:
 - 1. A single-line diagram of the building electrical distribution system.
 - 2. Floor plans indicating location and area served for all distribution.
 - 3. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - 4. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 5. The location, luminaire identifier, control and circuiting for each piece of lighting equipment.
 - 6. Contract Modifications, and actual equipment and materials installed.
 - 7. The locations and invert elevations of underground installations.

1.5 QUALITY ASSURANCE

- A. Manufacturer's listed in the equipment schedules are intended to establish quality only and does not limit equal products by other manufacturers. Electrical designs are based on the requirements for the specified manufacturers listed on the equipment schedules. Conduit, disconnects, motor starters, breakers, fuses and wire sizes are selected on basis of scheduled equipment. Increased current requirements necessitating larger wire, breakers, switches, etc., to accommodate any alternate or substitute manufacturer's equipment, other than as shown on drawings shall be provided without any increase in contract price by Contractor furnishing the equipment.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel." Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

PART 2 - PRODUCTS

NOT USED

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. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- B. All work shall conform to the requirements of all applicable codes, ordinances and regulations including the current rules and regulations of the NEC, the NFPA, O.S.H.A. and all state and local laws, codes and ordinances. All electrical installation work, including equipment and raceways, shall be supported and/or anchored in accordance with the International Building Code Seismic Requirements for this area.
- C. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- D. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- E. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- F. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.
- G. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- H. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Install access panel or doors where units are concealed behind finished surfaces.

- J. Install UL listed Fire Stops to meet the most stringent requirements of the specifications, the drawings, and as required by applicable codes, ordinances and regulations including the current rules and regulations of the NEC, the NFPA, and all state and local laws, codes and ordinances.
- K. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

- A. The responsibility for any cutting of construction which is required for the installation work shall be by the Contractor. The Contractor shall coordinate with the Architect before any cutting and obtain approval from the Engineer and the Architect prior to any cutting.
 - 1. Where openings for electrical work are provided under other sections of the specifications, this Contractor shall be responsible for locating and providing the proper dimensions for all such openings.
- B. Cutting shall be done with extreme care and in such a manner that the strength of the structure will not be endangered. Wherever possible, openings in concrete or masonry construction shall be by concrete saw or rotary core drill. Openings in any construction shall be cut the minimum size required for the installation of the work.
 - 1. Adequate protection shall be provided to prevent damage to adjacent areas and to prevent dust from spreading to adjacent areas.
 - 2. The use of jack hammers will not be permitted.
- C. Where openings or holes are cut in existing construction and the cutting breaks existing electrical circuitry or control circuitry, or communications, conduit and wiring, then it shall be the responsibility of the Contractor to have the circuitry, conduit and rewiring re-routed and to complete the circuitry as required and as approved by the Engineer. Temporary completion shall be provided where necessary before the permanent re-routing and completion work is finished. All costs for this work shall be the responsibility of the Contractor and no additions will be allowed to the Contract price.
- D. Before any cutting, patching, or finishing work is started, dust and moisture protection shall first be installed as required to protect adjacent construction and equipment and to prevent dust spreading from the immediate area where work is being performed.
- E. After any work is installed through any opening in walls, partitions, ceilings, or floors, the opening around the work shall be patched to match the existing construction, and the openings around conduits and around equipment shall be sealed watertight through floors and shall be sealed fireproof and smoke tight through floors, walls, partitions and ceilings.
- F. No structural member shall be cut without the approval of the Architect or his Consultant, and all such cutting shall be done in a manner directed by him.

END OF SECTION 260100

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SECTION 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

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. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls and Partitions: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Exposed Branch Circuits: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- G. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- H. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. 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.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Low-voltage control cabling.
 - 2. Control-circuit conductors.
 - 3. Identification products.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
 - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with NFPA 262.

2.4 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following
 - 1. Encore Wire Corporation.
 - 2. General Cable Technologies Corporation.
 - 3. Southwire Company.
- B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2 in raceway, complying with UL 44.
- C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway complying with UL 44 .
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway complying with UL 44.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
 - 1. Smoke control signaling and control circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1 and NFPA 70.

- B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Terminate all conductors, no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
3. Cables may not be spliced.
4. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
9. Support: Do not allow cables to lay on removable ceiling tiles.
10. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

- C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271500 "Communications Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

- D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

- E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

- F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.

- b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.4 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 - 1. Class 1 remote-control and signal circuits; No 14 AWG.
 - 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
 - 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.6 GROUNDING

- A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visually inspect UTP cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 260523

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SECTION 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:
 - 1. Common ground bonding with lightning protection system.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

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, 1/4 inch (6 mm) 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 (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

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.

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 tinned-copper conductor, No. 2/0 AWG minimum.
- 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 (25 mm), minimum, from wall 6 inches (150 mm) 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.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. 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.
- D. 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.

3.3 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. 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.
- C. 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. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.4 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.
 - a. 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 and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 5. Pad-Mounted Equipment: 5 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 260526

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SECTION 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

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. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 4. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 2. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 3. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. 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.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with 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 scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) 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 two-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 (90 kg).
- 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 Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. 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. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 4000-psi (20.7-MPa), 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 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 (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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SECTION 260533 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.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- 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. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel, set-screw type.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- 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 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- F. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

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. Concealed Conduit, Aboveground: Rigid steel conduit.
 - 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.
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: Type EMT.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: Rigid steel conduit.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch (21-mm) 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.
 - E. MC cable will be allowed in maximum lengths of 6'-0" for light fixture whips only. No other application of MC cable will be allowed.

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. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- L. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- M. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

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.

END OF SECTION 260533

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SECTION 260544 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant 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."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide [1/4-inch (6.4-mm)] annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors [2 inches (50 mm)] above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install 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.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548 VIBRATION CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Spring isolators.
 - 3. Hanger rod stiffeners.
 - 4. Anchorage bushings and washers.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods.
- 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.

3.3 ADJUSTING

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

SECTION 260553 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. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- 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.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field .
 - 2. Legend: Indicate voltage and system or service type.
- C. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field .
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.5 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.7 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 EQUIPMENT IDENTIFICATION LABELS

- A. 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 (10 mm).

2.9 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 (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 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 (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 - 5. Color: Black.

2.10 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. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. 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.
- I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot (3-m) maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
- C. 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 ungrounded service, feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - c. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. 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.
- G. 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.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting Baked-enamel warning signs.
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.
- I. 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.
- J. 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. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. 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. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - e. Enclosed switches.
 - f. Enclosed circuit breakers.
 - g. Enclosed controllers.
 - h. Variable-speed controllers.
 - i. Push-button stations.
 - j. Contactors.
 - k. Remote-controlled switches, dimmer modules, and control devices.
 - l. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260923 LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Lighting contactors.
- B. Related Requirements:
 - 1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. Electromechanical-Dial Time Switches: Comply with UL 917.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 - 3. Astronomic time dial.
 - 4. Eight-Day Program: Uniquely programmable for each weekday and holidays.
 - 5. Skip-a-day mode.
 - 6. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
 - 3. Time Delay: Thirty-second minimum, to prevent false operation.
 - 4. Lightning Arrester: Air-gap type.
 - 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

- A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 - 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 5. 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.
 - 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 7. Bypass Switch: Override the "on" function in case of sensor failure.
 - 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
 - B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is 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.
- 2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS
- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 - 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 - B. Wall-Switch Sensor:
 - 1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
 - 2. Sensing Technology: PIR.
 - 3. Switch Type: SP, field selectable automatic "on," or manual "on" automatic "off."
 - 4. Voltage: 120 V dual-technology type.
 - 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 - 6. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 - 7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- 2.5 LIGHTING CONTACTORS
- A. Description: Electrically operated and mechanically held, combination-type lighting contactors complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as matching the NEMA type specified for the enclosure.
 - B. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 - 1. Monitoring: On-off status.
 - 2. Control: On-off operation.
- 2.6 CONDUCTORS AND CABLES
- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, calibrate units. Calibration shall be finished before functional tests are executed. Calibrate after furniture is located in its finished position whenever possible.
 - 2. Functional Tests: Start units to confirm proper unit operation.
 - a. Occupancy Sensors: Confirm that the placement, sensitivity and time-out adjustments yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.
 - b. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.
 - c. Confirm photosensor controls reduce electric light levels based on the amount of usable daylight in the space as specified.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. The training shall be sufficient to allow the Owner's maintenance personnel to make ongoing adjustments for occupant requests and building modifications.

END OF SECTION 260923

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SECTION 262416 PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent 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.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
- C. Panelboard Schedules: For installation in panelboards.
- 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.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

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.

- b. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. 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.
- B. Incoming Mains Location: Top.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated 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.
 - 4. Neutral Bus: Neutral bus rated 100 percent of phase bus and UL listed as suitable for nonlinear loads.
 - 5. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawings by Square D, a brand of Schneider Electric:
- 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 (914 mm) high, provide two latches, keyed alike.
- D. Mains: As indicated.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker: 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. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings by Square D, a brand of Schneider Electric.:
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: As indicated.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. 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. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - h. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - i. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - j. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.
- 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 and NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- E. 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.
- F. Install overcurrent protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

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, feeder, and control circuit.
 - 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. 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. 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.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 262416

SECTION 262726 WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Weather-resistant receptacles.
 - 3. Snap switches.
 - 4. Wall-box motion sensors.
 - 5. Service fittings.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.3 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. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

2.2 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. 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. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

2.3 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
 - 1. Matching, locking-type plug and receptacle body connector.
 - 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
 - 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
 - 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
- C. Pilot Light Switches, 20 A:
 - 1. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.5 INDOOR OCCUPANCY SENSORS

- A. General Description: 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: 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.
- B. 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.
- C. Wall-Switch Sensors:
 - 1. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
- D. Wall-Switch Sensors:
 - 1. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

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 for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.7 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: Round, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable.

2.8 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.

- B. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: Gray, unless otherwise indicated or required by NFPA 70 or device listing.

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 (152 mm) 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 down, 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. Group adjacent switches under single, multigang wall plates.

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. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. 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.
- C. Test straight blade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g)

END OF SECTION 262726

SECTION 262913 ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.

1.2 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.
 - d. Short-circuit current rating of integrated unit.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.3 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.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Configuration: Nonreversing.
 - 2. Surface mounting.
 - 3. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Configuration: Nonreversing.
 - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 - 3. Surface mounting.
 - 4. Red pilot light.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Configuration: Nonreversing.
 - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
 - 3. Surface mounting.
 - 4. Red pilot light.
 - 5. N.O. and N.C. auxiliary contact.
- E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 1. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J fuses.

- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- 2. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
- 3. Nonfusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
- 4. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.C. and N.O. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
- 5. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.C. and N.O. alarm contact that operates only when MCCB has tripped.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12

2.3 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - a. Push Buttons: Recessed types; momentary as indicated.
 - b. Pilot Lights: LED types; colors as indicated; push to test.
 - c. Selector Switches: Rotary type.
- B. N.C. and N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable pneumatic time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Cover gaskets for Type 1 enclosures.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Install fuses in each fusible-switch enclosed controller.
- C. Install fuses in control circuits if not factory installed.

- D. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- F. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified 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 nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager and Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager and Owner before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 65 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

END OF SECTION 262913

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SECTION 265100 INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Interior lighting fixtures, lamps, and ballasts.
 2. Emergency lighting units.
 3. Exit signs.
 4. Lighting fixture supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
1. Physical description of lighting fixture including dimensions.
 2. Emergency lighting units including battery and charger.
 3. Ballast, including BF.
 4. Driver.
 5. Energy-efficiency data.
 6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 7. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For LED luminaires, submit the photometric data in electronic .ies format with adjustment factors, complying with IESNA Lighting Measurements Testing & Calculation Guide LM-79, of each lighting fixture.
 - b. Manufacturer Certified Data: Photometric data shall be certified by a 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 lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Installation instructions.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.4 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. Driver: One for every 100 of each type and rating installed not having a 10 year warrantee.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.
- E. Luminaires and lamps shall not exceed hazardous substance concentrations set for in the European Union's (EU) Restriction of the Use of Certain Hazardous Substances (RoHS) Directive, 2003.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located 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 and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Comply with UL 935 and with ANSI C82.11.
 - 2. Designed for type and quantity of lamps served.
 - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 - 4. Sound Rating: Class A.
 - 5. Total Harmonic Distortion Rating: Less than 10 percent.
 - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 7. Operating Frequency: 42 kHz or higher.
 - 8. Lamp Current Crest Factor: 1.7 or less.
 - 9. BF: 0.88 or higher.

10. Power Factor: 0.95 or higher.
 - B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
 - C. Ballasts for Low-Temperature Environments:
 - D. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.
 1. Dimming Range: 100 to 5 percent of rated lamp lumens.
 2. Ballast Input Watts: Can be reduced to 20 percent of normal.
 3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
 4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.
 - E. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
 1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
 2. Ballast shall provide equal current to each lamp in each operating mode.
 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.
- 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS
- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
 1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: Less than 20 percent.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 20 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 0.95 or higher unless otherwise indicated.
 9. Power Factor: 0.95 or higher.
 10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
- 2.5 EMERGENCY FLUORESCENT POWER UNIT
- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 2. Nightlight Connection: Operate one fluorescent lamp continuously.
 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 4. Battery: Sealed, maintenance-free type.
 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 6. 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.
- 2.6 DRIVERS FOR LED LIGHTS
- A. LED Drivers shall be Class 2 drivers.
 1. The driver shall be clearly marked to indicate Class 2.
 2. The driver shall have passed all the testing of ANSI/UL1310 or ANSI/UL6950.

- B. Transient Protection: Driver shall comply with ANSI/IEEE C62.41.1-2002 and ANSI/IEEE C62.41.2-2002, Category A operation.
- C. LED light engines shall make use of electrical interconnects which allow for replacement of the engine without cutting wires or using solder. Drivers shall be accessible without damage to the luminaire housing, trim, decorative elements or the carpentry (e.g., ceiling drywall) to which the luminaire is attached.
- D. All drivers used within the luminaire shall have a Class A sound rating. Ballasts and drivers should be installed in the luminaire in such a way that in operation, the luminaire will not emit sound exceeding a measured level of 24 dBA.

2.7 BALLASTS FOR HID LAMPS

- A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
 3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
 4. Open-circuit operation that will not reduce average life.
 5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.8 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. Internally illuminated exit signs shall not exceed 5 W per face.
 2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.9 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
 1. Battery: Sealed, maintenance-free, lead-acid type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Integral Time-Delay Relay: Holds unit on for fixed interval of [15] minutes when power is restored after an outage.
 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.

2.10 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2900 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
- C. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours unless otherwise indicated.
- D. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours unless otherwise indicated.
- E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.

2.11 LED LIGHTS

- A. Performance: Product shall be Energy Star qualified or shall meet the following:
 - 1. CRI for indoor luminaires: 80 (minimum).
 - 2. Color Temperature for indoor luminaires: 4000 K. The luminaire, LED light engine or integrated LED lamp shall also fall within the corresponding 7-step chromaticity quadrangles as defined in ANSI/NEMA/ANSI C78.377-2008.
 - 3. Off-state Power: Luminaires shall not draw more than 0.5 watts in the off state.
 - 4. Lumen maintenance in situ: 35,000 hours to L70 measured in accordance with current IES LM-80 and TM-21.
 - 5. Power Factor: 0.9 (minimum) at full output. ANSI C82.77-2002 sections 6 and 7.
 - 6. Operating Frequency: 120 hz minimum for steady state and dimming operation. Dimming operation shall meet the requirement at all light output levels.
 - 7. Luminaire shall have a minimum operating temperature of 0°F (-18°C) or below.
- B. Dimming: LED lamps shall be capable of continuous dimming, without flicker or noise from 30-100 percent.

2.12 HID LAMPS

- A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and color temperature 4000 K.

2.13 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with 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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - D. Suspended Lighting Fixture Support:
 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
 - E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 3.2 IDENTIFICATION
- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- 3.3 FIELD QUALITY CONTROL
- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- 3.4 STARTUP SERVICE
- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

END OF SECTION 265100

SECTION 270526 GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

- A. Comply with J-STD-607-A.

2.2 CONDUCTORS

- A. Comply with UL 486A-486B.
- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
- C. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- C. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

2.4 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, length to be 12-inches. The busbar shall be NRTL listed for use as TMGB and shall comply with J-STD-607-A.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

2.5 LABELING

- A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with J-STD-607-A.

3.3 APPLICATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- C. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm.)
- D. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch (900-mm) intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

3.4 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TMGB with No. 2 AWG bonding conductors.
- D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- E. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Boxes, enclosures, and cabinets.

1.2 ACTION SUBMITTALS

- A. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- F. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- D. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for general-use installation unless otherwise indicated.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-B.
 - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- I. Gangable boxes are prohibited.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - b. Vehicle Maintenance Bays.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Damp or Wet Locations: GRC.
 - 5. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway.
- B. Minimum Pathway Size: 3/4-inch (21-mm) trade size. Minimum size for optical-fiber cables is 1 inch (27 mm).
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and hot-water pipes. Install horizontal pathway runs above water piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

- N. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
 - O. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.
 - P. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch (21-mm) Trade Size and Smaller: Install pathways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (27-mm) Trade Size and Larger: Install pathways in maximum lengths of 75 feet (23 m).
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway 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.
 - Q. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway sealing fittings according to NFPA 70.
 - R. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where an underground service pathway enters a building or structure.
 - 2. Where otherwise required by NFPA 70.
 - S. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
 - T. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 - U. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
 - V. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
 - W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
 - X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
 - Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
 - Z. Set metal floor boxes level and flush with finished floor surface.
- 3.3 FIRESTOPPING
- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.
- 3.4 PROTECTION
- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

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SECTION 270544 SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

D. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

E. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Sealant 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."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 271500 COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. Telecommunications outlet/connectors.
 - 3. Cabling system identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. Wiring diagrams to show typical wiring schematics, including the following:

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for outlet.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the outlet/equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE

- A. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

2.4 UTP CABLE HARDWARE

- A. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- B. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Outlets:
 - 1. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of UTP and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 3. Legend: Machine printed, in the field, using adhesive-tape label.

2.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

2.7 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

- A. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- D. Cable will be considered defective if it does not pass tests and inspections.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Install cables in pathways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 - 1. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.2 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.

7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 9. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
 10. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

3.3 FIRESTOPPING

- A. Comply with TIA-569-B, Annex A, "Firestopping."
- B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- D. Cable and Wire Identification:
 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 4. UTP Performance Tests:

- a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
 - 5. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
 - B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
 - C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.6 DEMONSTRATION
- A. Train Owner's maintenance personnel in changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION 271500

SECTION 280513 CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire alarm wire and cable.
 - 2. Identification products.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Maintenance Data: For wire and cable to include in maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- 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.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." "Flexible metal conduit shall not be used."
 - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 FIRE ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.3 IDENTIFICATION PRODUCTS

- A. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Secure conduits to backboard when entering room from overhead.
3. Extend conduits 3 inches (75 mm) above finished floor.
4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."
 1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
 1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.3 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 IDENTIFICATION

- A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 280513

SECTION 280528 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Boxes, enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING AND FITTINGS

- A. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. EMT: Comply with ANSI C80.3 and UL 797.
- C. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 - 2. Expansion Fittings: Steel to match conduit type, complying with UL 467, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.2 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-B.
 - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Gangable boxes are prohibited.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
- B. Minimum Pathway Size: 1/2-inch (16-mm) trade size.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
 - 1. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 - 2. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements.
- B. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications wiring conduits for which only two 90-degree bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
 - I. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
 - J. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to conduit assembly to assure a continuous ground path.
 - K. Cut conduit perpendicular to the length. For conduits of 2-inch (53-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
 - L. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
 - M. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
 - N. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
 - O. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
 - P. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- 3.3 FIRESTOPPING
- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.
- 3.4 PROTECTION
- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 280528

SECTION 280544 SLEEVES AND SLEEVE SEALS FOR ELECTRONIC SAFETY AND SECURITY PATHWAYS
AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Grout.
 - 4. Silicone sealants.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant 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."
- B. Silicone Foams: Multicomponent, silicone-based, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance..
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 280544

SECTION 283111 COMBINED DIGITAL ADDRESSABLE FIRE-ALARM SYSTEM AND MASS
NOTIFICATION SYSTEM

1.1 SUMMARY

A. Section Includes:

1. Fire alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders
7. Addressable interface device.

1.2 SUBMITTALS

A. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include battery-size calculations.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
6. Include alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Delegated-Design Submittal: For smoke and heat detectors 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. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.
- H. Software and Firmware Operational Documentation:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
- 1.3 QUALITY ASSURANCE
 - A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
 - 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. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL.
- 1.4 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. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Faraday; Siemens Building Technologies, Inc.
 2. Fire Lite Alarms; a Honeywell company.
 3. Gamewell; a Honeywell company.
 4. NOTIFIER; a Honeywell company.
 5. Siemens Building Technologies, Inc.; Fire Safety Division.
 6. Silent Knight; a Honeywell company.
 7. SimplexGrinnell LP; a Tyco International company.
- 2.2 SYSTEM DESCRIPTION
 - A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
 - B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/horn and strobe evacuation.
 - C. Automatic sensitivity control of certain smoke detectors.
 - D. All components provided shall be listed for use with the selected system.
 - E. 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 SYSTEMS OPERATIONAL DESCRIPTION
 - A. Fire-alarm signal initiation shall be by one or more of the following devices:
 1. Manual stations.
 2. Heat detectors.
 3. Smoke detectors.
 4. Duct smoke detectors.
 5. Verified automatic alarm operation of smoke detectors.
 6. Automatic sprinkler system water flow.
 7. Fire-extinguishing system operation.
 - B. Fire-alarm signal shall initiate the following actions:
 1. Continuously operate alarm notification appliances including voice evacuation notices.
 2. Identify alarm at fire-alarm control unit and remote annunciators.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Unlock electric door locks in designated egress paths.

5. Release fire and smoke doors held open by magnetic door holders.
6. Activate alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 1. Valve supervisory switch.
 2. Low-air-pressure switch of a dry-pipe sprinkler system.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal ac voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator
 9. Voice signal amplifier failure.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciator.

2.4 FIRE-ALARM CONTROL UNIT

- A. General Requirements for Fire-Alarm Control Unit:
 1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 1. Annunciator and Display: Liquid-crystal type, 1line(s) of 40 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Smoke-Alarm Verification:
 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.
 3. Sound general alarm if the alarm is verified.
 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.
- D. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- E. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals shall be powered by 24-V dc source.
 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- F. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 1. Batteries: Sealed lead calcium.

2.5 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four or two-wire type for the application required.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Each sensor shall have multiple levels of detection sensitivity.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.7 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, red.

2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: System shall be capable of future expansion to provide a direct signal to elevator controller to initiate elevator recall.

2.11 NETWORK COMMUNICATIONS

- A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture **one** telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal. Transmitter shall automatically report telephone service restoration to the central station.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 1. Verification that telephone line is available.
 2. Programming device.
 3. LED display.
 4. Manual test report function and manual transmission clear indication.
 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
 2. Loss of ac supply or loss of power.
 3. Low battery.
 4. Abnormal test signal.
 5. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
1. Expand, modify, and supplement existing equipment as necessary to extend existing functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 2. Mount manual fire-alarm box on a background of a contrasting color.
 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing:
1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 3. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
 4. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
- E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- F. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- G. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.
- J. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- K. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- L. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, connect hardware and devices to fire-alarm system.
1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

- B. Fire alarm system shall have the capability to be expanded to include the following systems. Contractor to field verify existing conditions and shall provide addressable connections with a supervised interface device to the following devices and systems if existing. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 2. Supervisory connections at valve supervisory switches
- 3.4 IDENTIFICATION
 - A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - B. Install framed instructions in a location visible from fire-alarm control unit.
- 3.5 GROUNDING
 - A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- 3.6 FIELD QUALITY CONTROL
 - A. Field tests shall be witnessed by authorities having jurisdiction.
 - B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - D. Tests and Inspections:
 - 1. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 2. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 3. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - G. Prepare test and inspection reports.
 - H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.
- 3.7 DEMONSTRATION
 - A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

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DIVISION 31 EARTHWORK
SECTION 31 20 00 EARTH MOVING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SCOPE OF WORK

- A. Perform all excavating, filling, rough grading, finish grading, and compacting as shown on the Drawings, and to provide proper grades, profiles, and topography, as follows:
 - 1. Perform general excavation for structures to grades, lines, and levels as indicated.
 - 2. Perform general exterior grading, cutting, and filling required to transform existing grades for paved areas and lawns to grades shown on Drawings.
 - 3. Perform filling of embankment and backfilling for all work as required to conform with the lines, grades, thickness, and typical cross sections for paved areas shown on the Drawings.
 - 4. Cut ditches to divert water around parking area, and drives as shown on Drawings.
 - 5. Water shall be diverted or pumped out of the excavations until completion of the work for which the excavations were made.

1.03 UNDERGROUND UTILITIES

- A. Contractor shall verify locations of existing underground utilities (if any) prior to any excavation.

1.04 SUBSURFACE INVESTIGATION AND TESTING

- A. The Contractor shall employ the services of a qualified Soils Engineer to perform the following services:
 - 1. Test and advise if any soft pockets or unsuitable soils are encountered in the subgrade and foundation excavation.
 - 2. All miscellaneous testing as required in these specifications.
- B. The Contractor shall give timely notice to the Soils Engineer so that sampling and testing is performed in a time frame that is compatible with scheduled progress of the work.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EARTH EXCAVATION

- A. Strip building site 5'-0" beyond the building and pavement perimeter of topsoil and stockpile on site 24" below existing grade.
- B. Excavate for underfill below slabs on grade and other items indicated by drawings or otherwise necessary for construction. Remove any unsuitable soil from the site.
 - 1. After stripping and excavating, the exposed subgrade in the building areas shall be proofrolled using a moderately heavy loaded pneumatic-tired vehicle such as a 15 to 20 ton dump truck or scraper. Subgrade soils which are observed to rut or deflect excessively under the moving load shall be undercut to stable grade and replaced with compacted imported fill as specified in FILLING AND GRADING below.
- C. Excavate to elevations and dimensions indicated, plus minimum, yet sufficient space to permit erection of forms, shoring, waterproofing, insulation, and the inspection of foundations. Bottoms of footings shall be minimum 2'-6" below finish grade at exterior walls, approximately level, clean and shall be evenly pitched as required.
 - 1. Dress earth banks and bottoms for footing forms. Fill excess cut under footings with controlled fill or lean (2000 psi) concrete. Foundation excavations shall remain open as brief a period as possible and the bottoms of the footing areas shall not be allowed to dry and shall be maintained moist continuously from the time they are exposed until concrete is placed.
- D. Perform trench excavation for all utility lines and all other facilities called for on the Drawings. Refer to Section 31 23 33 Trenching and Backfilling.
- E. Should excavations reveal subgrade rock conditions, immediately notify Owner's Representative and do not proceed further until instructions are given and measurements made for purpose of establishing volume of added rock excavations. Rock excavation is defined as stone or boulders that cannot be removed by a power shovel or other normal power equipment without use of continuous drilling. Rock excavation shall be done as required at the unit price agreed upon by the Contractor and the Owner.
- F. Stockpile topsoil separately from other excavated material.

- G. Specifically notify Owner's Representative to inspect excavations and receive approval before placing concrete after all steel, plumbing, and electrical lines and any other work that occurs under slabs or in foundations is in place.
- H. Because the foundation materials generally tend to soften when exposed to free water, every effort shall be made to keep standing or flowing water out of the excavations if water is encountered. Water shall be diverted and/or pumped out of the excavations until completion of same and until after placing of concrete. All loose soils or soils softened due to moisture collection in footing trenches after excavation shall be removed prior to concrete placement.
- I. Ditches, swales, and gutters shall be finished to drain readily.

3.02 FILLING AND GRADING

- A. Fill building area to levels required with material composed of imported soil or granular material that will produce a dense, well-compacted fill with low to moderate volume change. Use no material containing sod, topsoil, humus, debris, stones larger than 4" nor frozen materials.
 - 1. Imported soil shall be non-expansive soil having liquid limit values below 45% and plasticity index values between 15 and 25. Acceptance of imported fill materials shall be subject to laboratory test of specific borrow area proposed.
 - 2. Final fill under interior concrete floor slabs, ramps, sidewalks, stairs, and exterior slabs, unless noted otherwise, shall be graded crushed limestone directly under floor slab of the thickness indicated on the Drawings. See Section 32 11 23 Aggregate Base Course.
 - 3. Sand fill shall be used only as a thin leveling course. Jetting or other hydraulic placing of fill materials will not be allowed.
- B. In cut areas the subgrade shall be scarified to minimum depth of 8", adjusted to within 2% optimum moisture content (0 to 4% above optimum for type CH soil), and recompacted according to the criteria for fill.
- C. In general, place no fills less than 2 days after concrete forms for structure have been removed and then only when approval is received from Architect.
- D. All fill shall be placed in layers not exceeding 8" in loose thickness, thoroughly compacted to a density of not less than 95 percent compaction based on a maximum unit dry weight as determined by the ASTM D 698 method. Fill material shall be placed at a moisture content range of 2 percent below to 3 percent above optimum moisture content. The moisture content of compacted fill beneath the floor slab shall be maintained from the time of subsoil excavation and filling to the time of placing floor slab concrete.
- E. Compacting layers of imported soil material in large areas shall be done with sheepsfoot roller. Compacting layers of earth material around foundations and confined areas shall be done with powered tamp. Compacting of aggregate shall be done by plate or roller vibratory action until no further consolidation is evident.
- F. This project has been designed utilizing a minimum soil bearing pressure as indicated on the Drawings for continuous and isolated footings. It shall be the responsibility of the Contractor to request that the Soils Engineer verify through field and/or laboratory testing as required that a minimum soil bearing pressure does exist prior to placement of concrete grade beams, footings, and slabs. Report shall be obtained from the Soils Engineer documenting the soil bearing capacity and submitted to the Architect/Engineer in triplicate.
- G. All fills or prepared subgrade materials shall be placed/prepared under close laboratory supervision and control to assure compliance with the project specifications. Conduct inspection and frequent testing by qualified personnel of the subgrade compaction prior to placement of fill and during placement. A testing frequency of at least three (3) field density tests for each 2,500 sq. ft. of fill lifts, but not less than three (3) tests per lift shall be performed. Reports shall be obtained from the inspecting agency documenting that the subgrade work complies with the specifications and submitted to the Owner's Representative in triplicate.
 - 1. All required testing and inspection cost shall be paid by the Contractor.

3.03 BACKFILLING AND GRADING

- A. Backfill around foundation with non-expansive debris-free earth having no stones larger than 4" and no frozen materials, thoroughly compacting with power tamp. Likewise compact fill under approaches, steps, walks, and other adjacent construction.
- B. Backfill in layers not exceeding 8" in loose thickness, thoroughly compacting to at least 95% of maximum dry density per ASTM D 698. Moisture content shall be controlled between 2% below and 3% above optimum content.
- C. Grade uniformly between elevations and slopes indicated on the Drawings, and round out any abrupt changes in slopes.
- D. Import additional fill material as may be required, or, should there be an excess, haul it away and deposit elsewhere.

3.04 AGGREGATE BASE AND PAVED AREAS

- A. In all areas where concrete curb and gutter or paving is to be installed, the finished subgrade shall be excavated to the bottom of the aggregate base to allow for construction of curb and gutter, aggregate base, and paving. Refer to Section 32 11 23 Aggregate Base Course.

3.05 TOPSOIL

- A. After rough grading is completed and approved, scarify subsoils in areas to be lawns to a depth of 4" and place a 6" layer of topsoil. Topsoil may need to be imported at no additional cost to the Owner. Compact to 85% of maximum density.
- B. Topsoil Material: Fertile, natural loam topsoil, free from stones, debris, clay, and weeds.
- C. Fill to finish grade indicated. Eliminate all water pockets and irregularities.

3.06 EXTENT OF FINISH GRADING

- A. Cut, fill and grade to extent of contours and elevations indicated by Drawings. All areas shall be free-draining. Make minor grade adjustments as may be directed by Owner's Representative without additional cost to Owner.
- B. Limits of fine grading shall be as required to smoothly transition proposed new finish grade into existing as shown on Site Plan.
- C. The Contractor shall set all grade stakes
- D. All fine grading shall be hand raked and prepared to receive seeding or sodding.

END OF SECTION

SECTION 31 23 33 TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SCOPE OF WORK

- A. The work of this Section consists of excavation of trenches, pits, and associated incidental elements relating to the construction of underground utility lines, structures, and appurtenances, and the backfilling of these excavations. There will be no distinction made in any definition or classification of excavation covered by this Section between wet or dry materials below the surface of the earth. Trench excavation shall be considered as unclassified, which shall consist of all material of whatever character encountered in the work, including soil, solid rock, fragmented rock, water, or other materials.
- B. Protection of Adjacent Property: The Contractor shall protect all excavations and trenches from settlement or displacement by approved means of bracing and shoring. All existing underground utilities, structures, and surface improvements shall be protected and their functional purpose preserved.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Earth Backfill: Earth backfill shall be earth previously excavated from the trench, free from perishable matter, frozen soil, and other material likely to become unstable when saturated with water and compacted. Excavated material that is unsuitable for backfill, and all boulders exposed by trenching shall be removed from the work area.
- B. Select Backfill: Where previously excavated earth is determined by the engineer to be unsuitable for backfill, the Contractor shall obtain and place earth from approved borrow areas.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

- A. Trench excavation shall be made with a sufficient working space to permit the placing, inspection, and completion of all work called for in the Contract.
- B. Should the trench be excavated more than six (6) inches below grade, the Contractor shall use only compacted earth or granular stone bedding material to establish grade.
- C. Trench excavation shall in all cases be continuous from the ground surface to the established trench depth. Materials excavated shall be stockpiled at the sides of the trench and within established area limits so as to minimize inconvenience and damage to vegetation and structures in the area.
- D. When unstable ground is encountered, the trenching shall be carried out utilizing trench shoring, bracing, and shields to prevent cave-ins.
- E. Inspection: After completion of excavations, the Contractor shall notify the Engineer or Architect that the trench or excavation may be inspected. Prior to placement of materials other than shoring, bracing, or sheeting, the excavation may be observed by the Engineer or Architect.

3.02 LINES AND GRADE FOR TRENCH EXCAVATION

- A. The Contractor shall furnish and set all stakes for the lines and grades as shown on the Drawings, including all grade boards, uprights, and accessory materials required. Grade boards shall be installed across the trench at intervals not to exceed 25 feet. The Contractor shall be held responsible for verification of lines and grades as established and shown on the Drawings. The Owner's Representative may check the line and grade at any given point before backfilling has been started, and if there is a variation of more than two-hundredths (0.02) of a foot from the true grade, the same shall be raised or lowered, as required.
- B. In the event a laser beam is used to set line and grade for the pipe laying operation, grade stakes shall be set at each manhole, and at 25 feet, 50 feet, 100 feet, and then 100-foot increments thereafter, upgrade of the manhole. The laser must be checked at the beginning of each day, and at each grade stake to insure the proper line and grade of the pipe.

3.03 SHEETING, SHORING, OR BRACING

- A. Sheeting, shoring, or bracing shall be placed by the Contractor wherever necessary for the proper preserving of any excavation, embankment or structure. Where the ground is of such a character or other conditions are such as to render it necessary, the sheeting shall be closely driven and to such depth below the lowest point of the final excavation as may be directed. The Contractor shall be held responsible for the sufficiency of all sheeting and bracing used, and for property damaged as the result of improper quality, strength, placing, maintaining or removing the same. No extra compensation will be made for sheeting and bracing whether left in place or removed. The Contractor shall, at his own expense, shore up, protect, and insure from injury all building, retaining walls, piers and footings, storm sewers, sanitary sewers, gas lines, water lines, fences, curbs, streets or other property likely to be injured during the process of the work, and he will be held responsible for all damage which may occur by reason of prosecution of the work. Sheeting, shoring, and bracing shall be provided, installed, and maintained to protect the excavation and insure open trench operations.

3.04 GROUNDWATER

- A. When groundwater is found which, in the opinion of the Engineer or Architect, affects the usefulness or satisfactory operation of any permanent work, he may direct special provisions to be taken. Such work shall be performed, and extra compensation shall be established by written change order.

3.05 BACKFILLING

- A. Material used for all backfilling shall be free from perishable matter and from other material which may become unstable when saturated with water after having been compacted. No frozen materials shall be used in the backfill. Care shall be taken to prevent damage to the pipe and structures. Special precautions shall be taken in backfilling over pipes. No backfill shall be placed over any portion of work unless first inspected by the Engineer or Architect. Backfill shall be carefully deposited in uniform layers not exceeding six inches in depth, and each layer shall be carefully and solidly tamped with mechanical tampers in such a manner as to avoid damage to or disturbing the completed work. Backfill for the trench shall be previously excavated gravel, sand, or earth. This backfilling shall be deposited and spread in layers and solidly tamped to 95 percent of maximum density. The method of securing adequate compaction shall be approved by the Engineer or Architect. As the trenches are backfilled, the Contractor shall remove surplus material, and regrade the surface leaving areas clear and in good order. The trenches shall be filled to the ground surface elevation that previously existed, unless the Drawings direct otherwise.
- B. The Contractor may be required to consolidate certain backfill material with water, in addition to other backfilling procedures. The water shall be furnished by the Contractor without cost to the Owner. Methods and procedures in using the water shall be approved by the Engineer or Architect prior to carrying out the operation.
- C. Clean-up of Backfilled Trenches: All excess excavation materials or blasting debris shall be cleaned up and disposed of by the Contractor.
- D. Field Quality Control: Density of compacted backfill shall be determined by the Contractor or others acting for the Contractor. Density shall be determined by ASTM Method D 1557, latest revision. If test results indicate required densities have not been attained, compaction shall continue, and soil retested until the required density is achieved.

END OF SECTION

SECTION 31 25 00 EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SCOPE OF WORK

- A. This Section specifies minimum requirements of the Contractor toward control of erosion, sediment runoff, and stormwater management during the performance of the Contract, and periods of construction activities.
- B. The Contractor shall implement measures, including best management policies, to control pollution of the waters of the state by soil and sediment carry-out from stormwater runoff.
- C. The Contractor shall reference publication EPA 832-R-92-005, October 1992, "Developing Pollution Prevention Plans and Best Management Practices" for development of stormwater pollution preventions, procedures, and identification of appropriate best management practices.

PART 2 PRODUCTS

2.01 EROSION CONTROL MATERIALS

- A. Class I Erosion Protection: Machine produced mat of synthetic fibers (nylon, polyethylene, or vinyl) woven into a mat of various strengths and thicknesses. Woven pattern provides soil retention prior to vegetation, and root zone reinforcement after vegetation. Fibers shall be UV stabilized and non-degradable. Acceptable products and manufacturers are as follows:
 - 1. "Miramat" - Mirafi, Inc.
 - 2. "Enkamat" - American Excelsior Company
 - 3. "Tensar Erosion Mat" - Tensar Corporation
 - 4. "P-300" - North American Green
- B. Class II Erosion Protection: Machine produced mat of wood, excelsior, or other organic fiber which has been reinforced by degradable synthetic netting or stitched nylon thread to provide a dense and durable blanket which provides soil retention prior to vegetation. Acceptable products and manufacturers are as follows:
 - 1. "Holdgrow" - Gulf States Paper
 - 2. "Durlex Blanket" - American Excelsior Company
 - 3. "SC150" - North American Green
- C. Anchors: Erosion control anchor material shall be as recommended by the manufacturer. At the minimum, the following shall be used: Wood stakes or metal or plastic pins are used for anchoring mat to the ground surface. Wood stakes shall be 1"x3" nominal stock cut in a triangular shape. Metal pins shall be 3/16" diameter steel with 2" diameter steel washer secured at head of pin. Plastic pins shall be barbed type. Wood stakes shall be 12" long minimum. Steel and plastic pins shall be 18" long minimum. Care shall be taken to assure that fasteners hold mat securely at the surface and have a sufficient ground penetration to resist pullout. Stake mat to the ground on 5 foot centers unless otherwise noted. Add extra stakes at depressions in ground surface where mat bridges over to assure ground conformity. Drive wood stakes to within 3" of ground surface. Do not drive flush to surface. Steel or plastic pins shall be driven flush to surface.
- D. Baled cereal straw shall be acceptable when used in conjunction with welded wire panels for the construction of sediment barriers.

PART 3 EXECUTION

3.01 PROCEDURES

- A. The Contractor shall construct sediment barriers across swales and constructed drainage ways at locations as needed to control erosion. These barriers shall consist of a single row of baled cereal straw placed perpendicular to the direction of flow. The row of baled straw shall be supported and retained by welded wire panels attached to 5 foot steel fence posts driven in the earth. Barriers shall be constructed prior to disturbance of the site and shall be maintained during the course of construction activities. Barriers shall be removed after vegetative cover has been established.
- B. During excavation of trenches for underground lines and appurtenances, excavated earth and stone shall be deposited on the side of the excavation having the higher elevation as measured perpendicular to the centerline of the trench.
- C. After backfilling and grading of the work area limits, activities specified under Section 32 92 00 SEEDING shall be initiated and completed. A Class II erosion protective mat shall be placed and pinned.

END OF SECTION

SECTION 31 31 16 TERMITE CONTROL

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. Treat soil under new construction and where new construction abuts existing buildings to provide a uniform toxic barrier at all routes of termite entry.

1.03 JOB CONDITIONS

- A. Soil treatment shall not be applied when the surrounding air and soil temperature, relative humidity, or wind velocity is not within the range acceptable in accordance with the manufacturer's recommendations.

1.04 WARRANTY

- A. Provide the Owner with a written five (5) year warranty on termite treatment.

PART 2 PRODUCTS

2.01 TREATMENT

- A. Dursban T.C. as manufactured by Dowel Anco, or approved equal, as a water emulsion at the concentrations specified and recommended by the manufacturer. If impervious soils make a reduction in volume of solution necessary, increase percentages of toxicant used in proportion to insure same amount of insecticide per linear or square foot.
- B. Minimum Treatment:
 - 1. One (1) gallon per 10 square feet as overall treatment under slab and attached landings, stairs, and ramps.
 - 2. Four (4) gallons per 10 linear feet along inside and outside of exterior foundation walls.

PART 3 EXECUTION

3.01 APPLICATION

- A. Apply soil treatment in accordance with manufacturer's instructions.

3.02 PROTECTION

- A. Allow no disturbance of treated soil between application and placing of concrete slab.

END OF SECTION

SECTION 32 16 00 CURB & GUTTER, SIDEWALKS, AND EXTERIOR CONCRETE SLABS

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 SUMMARY

- A. This work shall consist of construction of all exterior curbs and gutter, sidewalks, equipment pads, aprons for vehicular traffic, and miscellaneous concrete slabs.
- B. For aggregate base course refer to Section 32 11 23.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete: 3000 psi ready-mixed concrete (5% to 8% air-entrained) in accordance with Section 03 30 00 of these Specifications, except aprons for vehicular traffic shall be 4000 psi concrete (5% to 8% air-entrained).
- B. Reinforcement: Steel bars and steel welded wire fabric in accordance with Section 03 30 00 of these Specifications.

PART 3 EXECUTION

3.01 PLACEMENT AND FINISH

- A. Mix, place, reinforce, finish, and cure concrete in accordance with Section 03 30 00 of these Specifications.
- B. For Sidewalks, Aprons, and Pads: Provide ½" premolded asphalt expansion joint material full depth of concrete at intervals not exceeding 30 feet and where abutting curbs, pavings, and buildings.
- C. Form Edges. Moisten fill before placing concrete.
- D. Construct walks and pads 4" thick. Place steel reinforcement 2" below top surface. Concrete shall be rodded and tamped at the form line to produce a consistent smooth edge when forms are removed. Apron thickness shall be as indicated on the Drawings.
- E. Construct concrete paving 8" thick (non-reinforced) over 4" compacted crushed stone base over compacted soil. Saw cut joints as shown on drawings.
- F. Texture sidewalks and pads with "light broom finish" after hard steel trowel surfacing.
- G. Tool edges, cross-score to ¼ depth of slab at uniform intervals as shown on the Drawings. In areas not shown, cross-scoring shall be on five foot centers.
- H. Form curb and gutter to elevations indicated. Reinforce as indicated.
- I. Provide ½" premolded asphalt expansion joint material as called for on curb and gutter details. See details for control and expansion joint placement.
- J. For curb and gutter, broom finish by drawing fine-hair broom across concrete surface. Repeat operation, if required, to provide fine line texture.

END OF SECTION

SECTION 32 31 00 CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

- A. General Conditions and Special Conditions of the Contract and Division 1 of the Specifications are a part of this Section as if stated in full herein.

1.02 WORK INCLUDED

- A. Provide chain link fence system where shown on the Drawings, as specified herein, and as needed for a complete and proper installation and enclosure.

1.03 SUBMITTALS

- A. Submit shop drawings and product data including:
 - 1. Materials list of items proposed to be provided under this Section.
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
 - 3. Shop drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.
 - 4. Manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the work.

1.04 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Materials shall be in accordance with the Chain Link Fence Manufacturers Institute "Product Manual".

PART 2 PRODUCTS

2.01 DIMENSIONAL DATA

- A. Pipe sizes indicated are commercial pipe sizes.
- B. Tube sizes indicated are nominal outside dimensions.

2.02 GALVANIZING

- A. On steel framework and appurtenances, provide galvanized finish with not less than the following weight of zinc per sq. ft.
 - 1. Pipe: 1.8 oz., complying with ASTM A 120.
 - 2. Hardware and Accessories: Comply with Table 1 of ASTM A 153.
 - 3. Fabric: 2.0 oz., complying with Class II of ASTM A 121.

2.03 FABRIC

- A. Provide Number 9 gage or 0.148" wires in 2" mesh, with top and bottom selvages twisted and barbed.
- B. Provide fabric in one piece widths.

2.04 POSTS, RAILS, AND ASSOCIATED ITEMS

- A. End, corner, slope, and pull posts minimum size and weight: Pipe, 2.875" outside dimension, 5.79 lbs. per lin. ft.
- B. Line posts minimum size and weight as follows: Pipe, 2.375" outside dimension, 3.65 lbs. per lin. ft.
- C. Gate posts:
 - 1. Provide gate posts for supporting single gate leaf, or one leaf or a double gate installation, for nominal gate widths as follows: pipe, 4" outside diameter, 9.10 lbs. per lin. ft.
 - 2. Provide gate posts for sliding gates as follows:
 - a. For single leaf up to 13'-0" wide: pipe, 4.00" outside diameter, 9.10 lbs. per lin. ft.
 - b. For single leaf over 13'-0" wide: pipe 6.625" outside diameter, 18.97 lbs. per lin. ft.
- D. Top rails:
 - 1. Use 1.660" outside diameter pipe weighing 1.80 lbs. per lin. ft.
 - 2. Provide in manufacturer's longest lengths, with expansion type couplings approximately 6" long for each joint.
 - 3. Provide means for attaching top rail securely to each gate, corner, pull, slope, and end post.
- E. Post brace assemblies:
 - 1. Provide at end and gate posts, and at both sides of corner, slope, and pull posts, with the horizontal brace located at mid-height of the fabric.

2. Use 1.660" outside diameter pipe weighing 1.80 lbs. per lin. ft. for horizontal brace.
3. Use 3/8" diameter rod with turnbuckle for diagonal truss.
- F. Tension wire: Provide Number 7 gage galvanized coiled spring wire, conforming to ASTM A 824, at bottom of fabric.
- G. Post tops:
 1. Provide steel, wrought iron, or malleable iron cap designed as a weathertight closure. Cap and extension arm for three strands barbed wire. Extension arms shall withstand a weight of 200 lbs.
 2. Provide one cap for each post.
 3. Provide caps with openings to permit through passage of top rail.
- H. Stretcher bars:
 1. Provide one-piece lengths equal to full height of fabric, with a minimum cross-section of 3/16" x 3/4".
 2. Provide one stretcher bar for each gate and end post, and two for each corner, slope, and pull post, except where fabric is woven integrally into the post.
- I. Stretcher bar bands:
 1. Provide steel, wrought iron, or malleable iron, spaced not over 15" on centers, to secure stretcher bars to end, corner, pull, slope, and gate posts.
 2. Bands may be used also with special fittings for secure rails to end, corner, pull, slope, and gate posts.

2.05 GATES

- A. Fabrication:
 1. Fabricate gate perimeter frames of tubular members.
 2. Provide additional horizontal and vertical members to assure proper operation of the gate, and for attachment of fabric, hardware, and accessories.
 3. Space frame members not more than 8 feet apart.
 4. Fabricate single gate frames from pipe 1.90" outside diameter, 2.72 lbs. per lin. ft.
 5. Fabricate sliding gate frames from pipe of minimum 1.90" outside diameter, 2.72 lbs. per lin. ft., or from square tube of minimum 2" size, 2.60 lbs. per lin. ft.
 6. Assemble gate frames by welding with special malleable or pressed steel fittings and rivets for rigid connections.
 7. Use same fabric as used in the fence.
 8. Install fabric with stretcher bars at vertical edges as a minimum.
 9. Attach stretchers to gate frame at not more than 15" on centers.
 10. Attach hardware with rivets or by other means which will provide security against removal and breakage.
 11. Provide diagonal cross-bracing consisting of 3/8" diameter adjustable length truss rods on gates where required to provide frame rigidity without sag or twist.
- B. Gate hardware:
 1. Provide following for each swing gate:
 - a. Hinges: Pressed or forged steel, or malleable iron, to suit the gate size; non-lift-off type, offset to permit 180 degree opening. Provide 1½ pr. of hinges for each leaf over 6 feet in nominal height.
 - b. Latches: Provide forked type or plunger-bar type to permit operation from either side of the gate. Provide padlock eye as integral part of latch.
 2. Provide the following for sliding gates:
 - a. Keeper: Provide keeper for vehicle gates, which automatically engages the gate leaf and holds it in the open position until manually released.
 - b. Rollers: Provide upper and lower guide rollers. Upper rollers shall be ball bearing type in a truck assembly fitted within guide rails which allow for the cantilever of each leaf. Lower rollers shall be roller bearing type mounted on the posts and supporting the gate leaf.
 - c. Pair of gate latches: Fence-Loc #FL-100 or approved equal.

2.06 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Wire ties:
 1. For tying fabric to line posts, use Number 9 gage wire ties spaced 12" on centers.
 2. For tying fabric to rails and braces, use Number 9 gage wire ties spaced 24" on centers.
 3. For tying fabric to tension wire, use Number 11 gage hog rings spaced 24" on centers.
 4. Manufacturer's standard wire ties will be acceptable if of equal strength and durability.
- B. Concrete: Refer to Section 03 30 00.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Install fencing and gates in conformance with the Chain Link Fence Manufacturers Institute "Step-by-Step Installation Guide".
- B. Install posts at a maximum spacing of 10 feet on centers.
- C. Install corner or slope posts where changes in line or grade exceed a 30 degree deflection.

3.03 EXCAVATING

- A. Drill holes for post footings in firm, undisturbed or compacted soil, strictly adhering to the dimensions and spacing shown.
- B. Post hole dimensions:
 - 1. Provide 36" deep by 8" diameter foundations for line posts for fabric heights exceeding 5 feet.
 - 2. Provide 36" deep by 12" diameter foundations for all other posts.
- C. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the site if so directed.

3.04 SETTING POSTS

- A. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
- B. Center and align posts in holes.
- C. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation.
- D. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
- E. Trowel tops of footings, and slope or dome to direct water away from posts.
- F. Extend footings for gate posts to the underside of bottom hinge.
- G. Set keeps, stops, sleeves, and other accessories into concrete as required.
- H. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing material or other curing method approved by the Architect.
- I. Grout-in those posts which are set into sleeved holes or concrete construction, using non-shrink Portland cement grout or other grouting material approved by the Architect.

3.05 CONCRETE STRENGTH

- A. Allow concrete to attain at least 75% of its minimum 28-day strength before rails, tension wires, and/or fabric is installed.
- B. Do not, in any case, install such items in less than seven days after placement of concrete.
- C. Do not stretch and tension fabric and wire, and do not hang gates, until concrete has attained its full design strength.

3.06 RAILS AND BRACING

- A. Install fence with a top rail and bottom tension wire.
- B. Install top rails continuously through post caps or extension arms, bending to radius for curved runs.
- C. Provide expansion couplings as recommended by the fencing manufacturer.
- D. Provide bracing to the midpoint of the nearest line post or posts at all end, corner, slope, pull, and gate posts.
- E. Install tension wires parallel to the line of fabric by weaving through the fabric, and tying to each post with not less than Number 6 gage galvanized wire, or by securing the wire to the fabric.

3.07 INSTALLING FABRIC

- A. Leave approximately 2" between finish grade and bottom selvage.
- B. Excavate high points in the ground to clear the bottom of the fence.
- C. Place and compact fill to within 1" of the bottom of the fabric in depressions.
- D. Pull fabric taut and tie to posts, rails, and tension wires.
- E. Install fabric on outward side facing side of fence, and anchor to framework so that the fabric remains in tension after pulling force is removed.
- F. Install stretcher bars by threading through or clamping to fabric on 4" centers, and secure to posts with metal bands spaced 15" on centers.

3.07 INSTALLING GATES

- A. Install gates plumb, level, and secure for full opening without interference.
- B. Lubricate and adjust the hardware for smooth operation.

3.08 MISCELLANEOUS

- A. Use U-shaped tie wires, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
- B. Bend ends of wire to minimize hazards to persons and clothing.
- C. Fasteners:
 - 1. Install nuts for tension band and hardware bolts on side of fence opposite fabric side.
 - 2. Peen the ends of bolts to prevent removal of nuts.
- D. Repair coatings damaged in the shop or field erection, using a hot-applied repair compound applied in accordance with its manufacturer's recommendations as approved by the Architect.
- E. Protect fencing and gates from damage until acceptance by the Owner. Replace any items damaged by construction traffic or procedures.

END OF SECTION